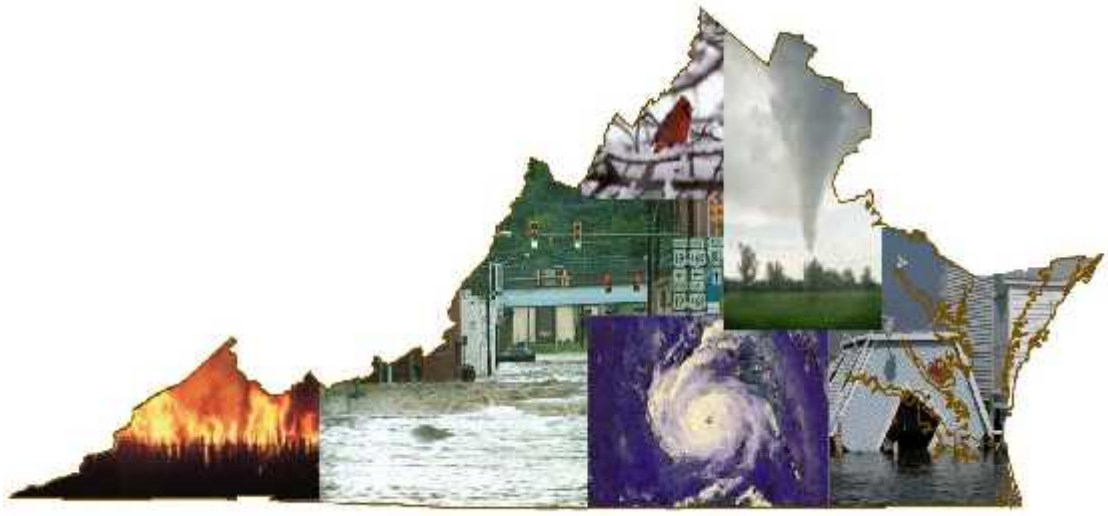
COMMONWEALTH OF VIRGINIA

Hazard Mitigation Plan



March 2018

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Table of Contents

Section 01	Introduction		
	1.1	Purpose of the State Hazard Mitigation Plan	1-1
	1.2	Disaster Mitigation Act of 2000	1-2
	1.3	44 CFR Part 201	1-2
	1.4	44 CFR Part 206	1-4
	1.5	Assurances and Adoption	1-5
	1.6	State Hazard Mitigation Plan Coordinator	1-5
	1.7	Overview of Plan	1-6
Section 02	Planning Process		
	2.1	2018 Update	2-1
	2.2	Final Draft Review	2-5
Section 03	Hazard Identification and Risk Assessment		
	3.1	Overview of the Hazard Identification & Risk Assessment Process	3.1-2
	3.2	Introduction to Virginia	3.2-1
	3.3	Declared Disasters and NCEI Data	3.3-1
	3.4	State Facilities, Critical Facilities, & Energy Pipeline Analysis	3.4-1
	3.5	Hazard Assessment and Ranking Methodology	3.5-1
	3.6	Local Plan Incorporation	3.6-1
	3.7	Communicable Disease	3.7-1
	3.8	Drought	3.8-1
	3.9	Earthquake	3.9-1
	3.10	Flooding	3.10-1
	3.11	Flooding Due to Impoundment Failure	3.11-1
	3.12	Karst	3.12-1
	3.13	Landslide	3.13-1
	3.14	Land Subsidence	3.14-1
	3.15	Non-Rotational Wind	3.15-1
	3.16	Solar Storm	3.16-1
	3.17	Tornado	3.17-1
	3.18	Wildfire	3.18-1
	3.19	Winter Storm	3.19-1
	3.20	HIRA Summary	3.20-1
Section 04	Capability Assessment		
	4.1	Statewide Capability Assessment	4-1
	4.2	Pre-Disaster Mitigation Programs	4-2
	4.3	Post-Disaster Mitigation Programs	4-3
	4.4	Funding Capabilities	4-4
	4.5	Federal Agencies and Programs	4-27
	4.6	State Programs and Capabilities	4-39

4.7 Local Capabilities 4-45

Section 05 Mitigation Strategy
5.1 2018 Plan Update 5-1
5.2 Virginia Mitigation Goals 5-2
5.3 Virginia Mitigation Categories 5-2
5.4 Strategy and Project Prioritization 5-6
5.5 Mitigation Actions 5-8
5.6 Virginia Risk Reduction Priorities 5-102

Section 06 Local Plan Coordination
6.1 Local Hazard Mitigation Plan Development 6-1
6.2 Defining the Local Planning Jurisdictions 6-3
6.3 Local Funding for Mitigation Planning 6-5
6.4 Prioritizing Funding for Local Hazard Mitigation Plans 6-7
6.5 Providing Support for Plan Revisions 6-8
6.6 Providing Technical Assistance 6-9
6.7 Local Hazard Mitigation Planning Workshops 6-9
6.8 Local Mitigation Planning Assistance Guides 6-10
6.9 State Review of Local Hazard Mitigation Plans 6-10
6.10 Summary of Loss Avoidance Study 6-11

Section 07 Enhanced Plan Requirements
7.1 Compliance with Standard Plan Requirements 7-1
7.2 Integrated Planning 7-1
7.3 Project Implementation Capability 7-2
7.4 Mitigation Action Assessment 7-12
7.5 Effective Use of Available Mitigation Funding 7-18
7.6 Commitment to a Comprehensive Mitigation Program 7-22
7.7 Executive Actions 7-23

Section 08 Plan Maintenance and Implementation
8.1 Plan Monitoring Procedures 8-1
8.2 Tracking Strategies and Projects 8-2
8.3 Plan Evaluation and Implementation 8-3
8.4 Support Post Disaster Mitigation Operations 8-6
8.5 Project Closeout 8-6
8.6 Plan Amendments 8-8
8.7 Timeline for Next Five Year Update 8-8

Appendices

A Acroynms
B Glossary
C Disaster Mitigation Act of 2000
D State Agency Annual Report Form

E Meeting Documentation
F Local Hazard Mitigation Plan Status
G Enhanced Plan Crosswalk
H HMGP State Administrative Plan
I FEMA Approval Letter
J State Adoption
K Threats
L Loss Avoidance Study
M Stakeholder Engagement

44 CFR, §201.4 – Standard State Mitigation Plans

§201.4: Plan requirement. States must have an approved standard State Mitigation Plan meeting the requirements of this section as a condition of receiving non-emergency Stafford Act assistance and FEMA mitigation grants. Emergency assistance provided under 42 USC 5170a, 5170b, 5173, 5177, 5179, 5182, 5183, 5184, 5192 will not be affected. Mitigation planning grants provided through the Pre-disaster Mitigation (PDM) program, authorized under section 203 of the Stafford Act, 42 USC 5133, will also continue to be available. The mitigation plan is the demonstration of the State's commitment to reduce risks from natural hazards and serves as a guide for State decision makers as they commit resources to reducing the effects of natural hazards.

§201.4(c)(7): The plan must include assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c). The State will amend its plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d).

44 CFR, §201.5 – Enhanced State Mitigation Plans

§201.5(a): A State with a FEMA approved Enhanced State Mitigation Plan at the time of a disaster declaration is eligible to receive increased funds under the HMGP, based on twenty percent of the total estimated Stafford Act disaster assistance. The Enhanced State Mitigation Plan must demonstrate that a State has developed a comprehensive mitigation program, that the State effectively uses available mitigation funding, and that it is capable of managing the increased funding. In order for the State to be eligible for the 20 percent of HMGP funding, FEMA must have approved the plan within 5 years prior to the disaster declaration.

1.1 Purpose of the State Hazard Mitigation Plan

The *Commonwealth of Virginia Hazard Mitigation Plan* provides guidance for hazard mitigation activities within the Commonwealth. Its vision is supported by goals, categories, and actions for Virginia that will reduce or prevent injury from natural hazards to residents, communities, state facilities, and critical facilities. The *Commonwealth of Virginia Hazard Mitigation Plan* has undergone a full revision for this required 2018 update.

The *Commonwealth of Virginia Hazard Mitigation Plan* was first approved by FEMA Region III on September 28, 2004. The Commonwealth received approval of its enhanced plan status on March 14, 2007. The plan was updated in 2010 and in 2013; however, during the 2013 update the Commonwealth did not pursue enhanced plan status. The 2018 version is an update from the 2013 plan, and documents successful completion of FEMA's enhanced plan requirements (see Section 07).

This plan fulfills the standard state mitigation planning requirements (44 CFR §201.4) of the Disaster Mitigation Act of 2000 (DMA2K; Public Law 106-390, signed into law October 10, 2000). The DMA2K amends the 1988 Robert T. Stafford Disaster Relief and Emergency Assistance Act, and reinforces the importance of mitigation planning, emphasizing planning for disasters before they occur. Section 322 of the act specifically addresses mitigation planning at state and local levels. New requirements are identified that allow Hazard Mitigation Grant Program (HMGP) funds to be used for mitigation activities and projects for states and localities with Hazard Mitigation Plans approved by November 1, 2004.

1.2 Disaster Mitigation Act of 2000

In October 2000, the president signed into law the Disaster Mitigation Act of 2000 (DMA2K; Public Law 106-390). The DMA2000 amends the 1988 Robert T. Stafford Disaster Relief and Emergency Assistance Act, and reinforces the importance of mitigation planning, emphasizing planning for disasters before they occur. Local and state governments must develop and adopt hazard mitigation plans to remain eligible for federal disaster assistance and grant funds.

This enhanced pre-disaster planning effort is intended to support state and local governments' efforts to articulate accurate, targeted, and prioritized needs for hazard mitigation that will reduce exposure to natural hazards and threats. This plan will assist in timely allocation of funding and more effective risk reduction strategies and projects.

1.3 44 CFR Part 201

44 CFR § 201.1 et seq. was promulgated by the Federal Emergency Management Agency (FEMA) on February 26, 2002 in order to implement DMA 2000. The interim final rule was amended several times to address standard and enhanced state plans during 2007. Guidance for local plans has been revised to address local plan revisions on July 1, 2008.

In addition, guidance for the Flood Mitigation Assistance Program (44 CFR §201.4 et seq.) requires amendment of state plans per a new crosswalk for these programs issued on January 14, 2008. The rule addresses state mitigation planning, and specifically in 44 CFR §201.3(c) identifies the states' mitigation planning responsibilities, which include:

1) Prepare and submit to FEMA a Standard Hazard Mitigation Plan following criteria established in 44 CFR §201.4 as a condition of receiving Stafford Act assistance (except emergency assistance).
2) For consideration for 15% Hazard Mitigation Grant Program funding, prepare and submit a State Mitigation Plan in accordance with 44 CFR §201.5, which must be reviewed and updated, if necessary, every three years[1] from the date of the approval of the previous plan.
3) Review and if necessary, update the Standard State Mitigation Plan by November 1, 2004, and every three years from the date of approval of the previous plan in order to continue program eligibility.
4) Make available the use of up to the seven percent of HMGP funding for planning in accordance with 44 CFR §206.434. See 44 CFR §201.3(c).

44 CFR §201.4, Standard State Mitigation Plans, lists the required elements of state hazard mitigation plans. Under 44 CFR §201.4(a), by November 1, 2004 states must have an approved Standard State Hazard Mitigation Plan that meets the requirements of the regulation to receive Stafford Act assistance. The planning process, detailed by 44 CFR §201.4(b), must include coordination with other state agencies, appropriate federal agencies and interested groups.

44 CFR §201.4(c), Plan content, identifies the following elements that must be included in a state hazard mitigation plan:

1) A description of the planning process used to develop the plan;
2) Risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan;
3) A Mitigation Strategy that provides the state's blueprint for reducing losses identified in the risk assessment;
4) A section describing Coordination of Local Mitigation Planning;
5) A Plan Maintenance Process, including a method and schedule for monitoring, evaluating and revising the plan; a system for monitoring implementation of mitigation strategies and projects; and a system for reviewing progress in achieving goals, objectives and strategies as well as project implementation;

6) A Plan Adoption Process for formal adoption by the State prior to submittal to FEMA for final review and approval; and
7) Assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to grant funding periods, in compliance with 44 CFR §13.11(c). The state must amend its plan whenever needed to reflect changes in state or federal laws and statutes as required by 44 CFR §13.11(d).
8) Revisions to plans per guidance issued January 14, 2008 must include a repetitive loss strategy for state eligibility for 90% federal funding for the Flood Mitigation Assistance Program for FY2009. Plan revisions must in compliance with 44 CFR §201.4.

1.4 44 CFR Part 206

On February 26, 2002, FEMA also changed 44 CFR Part 206 in order to implement DMA 2000 (See 67 Federal Register 8844 [February 26, 2002]). Changes to 44 CFR Part 206 authorize hazard mitigation grant program funds for planning activities and increase the amount of HMGP funds available to states that develop an Enhanced Mitigation Plan. FEMA amended Part 206 in 2006 following the passage of the Katrina Reform Act which restored HMGP funding to 15% of eligible disaster recovery costs for states with approved Standard Mitigation Plans.

In addition, through 44 CFR §206.400, states receiving any disaster assistance funding under the Stafford Act must conduct repairs or construction funded by a disaster loan or grant in accordance with applicable standards such as the minimum standards of the National Flood Insurance Program (NFIP) and standards substantially equal to the recommended provisions of the National Earthquake Hazards Reduction Program (NEHRP).

§44-146.17. Powers and Duties of the Governor.

The Governor shall have, in addition to his powers hereinafter or elsewhere prescribed by law, the following powers and duties:

(1) He may adopt and implement the Emergency Operations Plan, which provides for state-level emergency operations in response to any type of disaster or large-scale emergency affecting Virginia and that provides the needed framework within which more detailed emergency plans and procedures can be developed and maintained by state agencies, local governments and other organizations.

(2) To appoint a State Coordinator of Emergency Management and authorize the appointment or employment of other personnel as is necessary to carry out the provisions of this chapter, and to remove, in his discretion, and all persons serving hereunder;

§44-146.22. Development of measures to prevent or reduce harmful consequences of disasters.

In addition to disaster prevention measures included in state, local and inter-jurisdictional emergency operations plans, the Governor shall consider, on a continuing basis, hazard mitigation or other measures that could be taken to prevent or reduce the harmful consequences of disasters. At his direction, and pursuant to any other authority, state agencies, including, but not limited to, those charged with responsibilities in connection with floodplain management, stream encroachment and flow regulation, weather modification, fire prevention and control, air quality, public works, land use and land-use planning, and construction standards, shall make studies of disaster prevention. The Governor, from time to time, shall make recommendations to the General Assembly, local governments, and other appropriate public and private entities as may facilitate measures for prevention or reduction of the harmful consequences of disasters.

1.5 Assurances & Adoption

The plan serves as the *Commonwealth of Virginia Hazard Mitigation Plan*, and is formally adopted by the Governor of Virginia. In addition, the plan has been cross-walked through the Emergency Management Accreditation Program (EMAP) and has been deemed consistent with the standards of EMAP relative to hazard mitigation.

The Code of Virginia §44-146.17 allows the Governor to appoint an Emergency Coordinator to carry out all provisions of the Code of Virginia relating to emergency preparedness, response, and recovery. The Code of Virginia § 44-146.22 specifically authorizes the Governor to consider hazard mitigation measures to prevent or reduce the harmful consequences of disasters. The Governor is expected to make recommendations to the General Assembly, local governments, and appropriate public and private entities.

This Plan supersedes all previous versions of the plan.

The Commonwealth of Virginia Department of Emergency Management, pledges that it will:

1. Comply with all applicable federal statutes and regulations in effect with respect to periods for which it receives grant funding, in compliance with 44 CFR §13.11(c); and
2. Amend this plan whenever necessary to reflect changes in state or federal laws and statutes as required in 44 §CFR 13.11(d).

1.6 State Hazard Mitigation Plan Coordinator

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Planning Division
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1.7 Overview of Plan

Each chapter begins with the appropriate requirements from the Disaster Mitigation Act of 2000 to provide reference and context to the issues discussed within the chapter. A brief introduction to the section is followed by relevant information, charts, tables, and maps, which fulfill regulation requirements. The main chapters of the plan follow primary requirements of the hazard mitigation planning law.

[1] The three-year requirement was later amended to five years.

Disaster Mitigation Act of 2000

§201.4(b): An effective planning process is essential in developing and maintaining a good plan. The mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives.

§201.4(c)(1): Description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated

2.1 2018 Update

This plan was developed and updated in accordance with the planning requirements outlined in section 404 of the Robert T. Stafford Act as amended by the Disaster Mitigation Act of 2000 (DMA2K). Since the last plan update, the Commonwealth of Virginia has experienced two Federal Disaster Declarations. The concept of mitigation planning is to develop a plan that identifies hazards and their impacts to the Commonwealth, as well as actions to reduce the future impacts. In order to develop such a plan, a group of stakeholders and subject matter experts need to be brought together.

Both the Virginia Hazard Mitigation Advisory Committee (VHMAC) and Virginia Hazard Mitigation Working Group (VHMWG) were active in the 2018 update. The VHMAC is a small group of decision makers, and the VHMWG is a larger group of subject matter experts than were brought into the planning process as needed.

There are twenty multi-jurisdiction plans incorporated into this update: Accomack-Northampton, Commonwealth Regional, Central Shenandoah, Cumberland Plateau, George Washington, Hampton Roads, LENOWISCO, Middle Peninsula, Mount Rogers, New River Valley, Northern Neck, Northern Shenandoah, Northern Virginia, Rappahannock Rapidan, Region 2000, Richmond-Crater, Roanoke Valley-Alleghany, Southside, Thomas Jefferson, and West Piedmont. More information on local plan incorporation can be found in Chapter 3, HIRA, Section 3.6 and Chapter 4, Capability Assessment.

The VHMAC determined that the methodologies for analysis in the plan were still relevant, and that the data required update based on events that occurred after the 2013 plan update.

The VHMAC reviewed the hazards from the 2013 plan and made some changes. There are now 13 hazards included in this plan update: communicable disease, drought (including extreme heat), earthquake, flood, impoundment failure, karst, landslide, land subsidence, non-rotational wind, solar storm, tornado, wildfire, and winter weather (including extreme cold). Threats are included in Appendix K and incorporate results from the existing COV THIRA.

Over the course of the planning period, VHMAC and VHMWG meetings have taken place to review and prioritize project applications for HMA as well as general planning meetings for this update. More details can be found below:

Table 2.1-1: VHMAC and VHMWG Meeting Summaries

Date	Meeting Name	Summary
February 27, 2017	Kick-Off Meeting	Two separate meetings were held for the VHMAC and VHMWG. Both were given an overview of the project. The VHMAC went through a hazard identification exercise to decide which hazards to include in the update. The results of the hazard identification exercise were provided to the VHMWG during the later meeting. Both the VHMAC and VHMWG were given extended opportunity to update the capability assessment.
June 7, 2017	Mitigation Strategy and Capability Assessment Meeting	Two separate meetings were held for the VHMAC and VHMWG. The meetings focused on the review and update of the mitigation goals as well as the review of the mitigation actions and prioritization methodology. The capability assessment was discussed again in further detail, and both the VHMAC and VHMWG were provided another opportunity to provide updates.
June 26 and 28, 2017	Conference Calls regarding Mitigation Strategy	Two conference calls were held for committee and working group members to discuss mitigation action updates.

Date	Meeting Name	Summary
August 31, 2017	Plan Monitoring and Process Update	Two separate meetings were held for the VHMAC and VHMWG. Both groups received a progress report on the update to each section of the plan, and a discussion was held regarding the monitoring and maintenance procedures outlined in the updated plan, including the post-approval involvement and responsibilities of the committee members. The timeline for project completion was discussed in detail, including the final draft review period.

In addition to the formal meetings and calls, periodic progress updates were provided to all members of both groups. As needed, calls and emails were also held with members of both groups, to clarify questions or information provided. Draft sections of the updated plan were provided to the members for their review and comment, prior to creation of the final draft of that section. Additionally, VDEM was provided both a bi-weekly progress report and a monthly status report, to document the progress of the tasks related to the plan update.

Table 2.1-2: VHMAC Members

Name	Office/Department/Agency
Donna Pletch	Virginia Department of Emergency Management
Robbie Coates	Virginia Department of Emergency Management
Matt Wall	Virginia Department of Emergency Management
Ed Porner	Virginia Department of Emergency Management
Charley Banks	Virginia Department of Conservation and Recreation Division of Dam Safety and Floodplain Management
Shep Moon	Virginia Department of Environmental Quality (Coastal Planner)
John Miller	Virginia Department of Forestry
Brandon de Graaf	Virginia Department of General Services
Julie Langan	Virginia Department of Historic Resources
Kyle Flanders	Virginia Department of Housing and Community Development
Matt Heller	Virginia Department of Mines, Minerals, and Energy
Matt Lott	Virginia Department of Transportation
Bob Coiner	Virginia Association of Planning District Commissions
Hui-Shan Walker	Local Representative- Regions East
Kevin Flippen	Local Representative- Regions West
Jim Redick	City of Norfolk
Anna McRay	City of Richmond

Name	Office/Department/Agency
Rich Mortimer	Virginia Department of Emergency Management (Planning)
Bill Mahoney	Virginia Department of Emergency Management (Planning)
Anne Witt	Virginia Department of Mines, Minerals, and Energy

Table 2.1-3: VHMWG Members

Name	Office/Department/Agency
Donna Pletch	Virginia Department of Emergency Management
Carolyn Bissett	Virginia Department of Agriculture and Consumer Service
Charley Banks	Virginia Department of Conservation and Recreation (National Flood Insurance)
Stewart Baker	Virginia Department of Emergency Management (Hurricanes)
Mark Slauter	Virginia Department of Emergency Management (Flood/Dams)
Dave Hartman	Virginia Department of Emergency Management (HAZMAT)
Chris Thompson	Virginia Department of Emergency Management (GIS)
Barry Matthews	Virginia Department of Health (Office of Drinking Water)
Steve Harrison	Virginia Department of Health (Radiological Health)
Lean Abdelaziz	Virginia Department of Health
Fred Turck	Virginia Department of Forestry
David Spears	Virginia Department of Mines, Minerals, and Energy
Don LeMond	Virginia Department of Treasury
LTC James Williams	Virginia Department of Military Affairs
Robin Liberto	Virginia State Police (Fusion Center)
Stacie Neal	Secretary of Public Safety (Critical Infrastructure)
Isaac Janak	Secretary of Public Safety (Cyber Security)
Matt McCullough	Federal Emergency Management Agency
Mari Radford	Federal Emergency Management Agency
Phil Hysell	National Weather Service- Blacksburg
Chris Strong	National Weather Service- Sterling
Bill Sammler	National Weather Service- Wakefield
Glenn Carrin	National Weather Service- Morristown
Emily Steinhilber	Old Dominion University
Michelle Hamor	United States Army Corps of Engineers
Paul Moye	United States Army Corps of Engineers
Russ Lotspeich	United States Geological Survey
Randy Orndorff	United States Geological Survey
Shaun Wicklein	United States Geological Survey
Jerry Stenger	University of Virginia State Climatology Office

Name	Office/Department/Agency
Donald McCann	Virginia Institute for Marine Science
Cheryl Teagle	Virginia Institute for Marine Science
Martin Chapman	Virginia Tech Seismological Observatory
Skip Stiles	Wetlands Watch
Mark Gauthier	SBC of Virginia (VOAD)
Anne Witt	Virginia Department of Mines, Minerals, and Energy
Anne Smith	Virginia Institute for Marine Science
Rich Mortimer	Virginia Department of Emergency Management (Planning)
Bill Mahoney	Virginia Department of Emergency Management (Planning)
Mary Carson-Stiff	Wetlands Watch
Marcie Occhi	Virginia Department of Mines, Minerals, and Energy
Dina DiCicco	Virginia Department of Conservation and Recreation
Kristin Owen	Virginia Department of Conservation and Recreation

2.2 Final Draft Review

A draft of the plan was distributed to the VHMAC, VHMWG, and VDEM for review and comment. These groups were asked comment on all sections and appendices of the updated plan. A 21-day comment period was allowed from October 15, 2017 through November 06, 2017. Comments were reviewed and necessary changes were made to the final draft of the plan. The final draft of the updated plan was delivered to VDEM on November 15, 2017, for submission to FEMA.

Chapter 3: Hazard Identification & Risk Assessment (HIRA)

It is well known that many different types of natural hazards impact Virginia. The primary task of this revision was to improve the hazard analysis using GIS to determine population vulnerability, population impact, geographic extent, deaths and injuries, crop and property damage, and overall risk. Sections 3.1 through 3.6 provide background information and data that was used in the HIRA. Section 3.5 fully explains how these criteria were developed and used with the best available data.

- Section 3.07 Communicable Disease
  - Hazard Rank = Medium-Low
- Section 3.08 Drought
  - Hazard Rank = Medium-Low
- Section 3.09 Earthquake
  - Hazard Rank = Medium-Low
- Section 3.10 Flood
  - Hazard Rank = High
- Section 3.11 Flooding Due to Impoundment Failure
  - Hazard Rank = Low
- Section 3.12 Karst (Sinkholes)
  - Hazard Rank = Low
- Section 3.13 Landslide
  - Hazard Rank = Medium-Low
- Section 3.14 Land Subsidence
  - Hazard Rank = Low
- Section 3.15 Non-Rotational Wind
  - Hazard Rank = Medium
- Section 3.16 Solar Storm/Flare
  - Hazard Rank = Low
- Section 3.17 Tornado
  - Hazard Rank = Medium-High
- Section 3.18 Wildfire
  - Hazard Rank = Medium-Low
- Section 3.19 Winter Weather
  - Hazard Rank = Medium

Disaster Mitigation Act of 2000

§201.4(c)(2): Risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.

The risk assessment shall include the following:

§201.4(c)(2)(i): An overview of the type and location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate;

§201.4(c)(2)(ii): An overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed;

§201.4(c)(2)(iii): An overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

Section 3.1: Overview of the Hazard Identification and Risk Assessment Process

Background

The Hazard Identification and Risk Assessment (HIRA) section of the *Commonwealth of Virginia Hazard Mitigation Plan* was prepared by Witt O'Brien's, LLC, with input and oversight from several Commonwealth, regional, local, and federal partners, led by the Virginia Department of Emergency Management (VDEM). Sections 3.1 through 3.6 provide background information about available data, local plans, and ranking methodology. The individual hazard sections (3.7 – 3.19) of this chapter cover the following three requirements for the HIRA:

- Identifying and profiling hazards
- Assessing vulnerabilities
- Estimating potential losses

The final section, 3.20, provides a summary of the previous sections. Two important considerations that permeate this chapter are overall data availability and ability to compare hazards to each other. FEMA guidelines emphasize using the best available data for this plan. Data availability issues were compounded by the lack of consistency and standardization in the local plans. Inadequate information about local features (such as critical facilities and infrastructure) still exist for this revision, though all the local plans are either approved, in the process of being updated, or currently under review. Section 3.4 describes the facility datasets that were used to complete this revision and suggestions for increasing the usability of locally maintained datasets. In the following sections of this chapter, the impact of these data limitations is shown through different vulnerability assessment and loss estimation methods used for hazards.

Since the approval of the 2013 *Commonwealth of Virginia Hazard Mitigation Plan*, VDEM contracted Witt O'Brien's to revise and update the plan – including this HIRA - and to maintain the previously developed ranking methodology. Local plan information and data was also updated and used to the extent possible, as described in section 3.6.

Hazard Identification and Section Overview

A wide range of hazards have the potential to threaten both life and property in Virginia. These hazards were classified as weather related, geological related, and other hazards. Local plans were evaluated to verify the consideration and ranking of these hazards. Section 3.6 of this chapter defines these hazards and how they are incorporated into this revision.

During the preparation of this plan, each of the hazards have been evaluated for impact on Virginia both on a comparative basis using geographic information systems (GIS) and separately

for each hazard. This allows for comparison between counties of the relative exposures to hazards and sets the groundwork for local hazard mitigation plan updates. The ranking and analysis in this plan is in terms of relative risk to other jurisdictions in the Commonwealth. For example, the tornado ranking and analysis in this chapter is an effort to highlight the jurisdictions within Virginia that are more likely to be at risk. The highest-ranking communities in Virginia, when compared to the states in 'tornado alley', would probably be considered low risk. All the hazards addressed in this plan are only relative to the jurisdictions in Virginia.

HIRA Timeline for 2018 FEMA Approval

- December 2016 – VDEM contracted Witt O'Brien's, LLC to revise and update plan, including HIRA
- February 2017 – Kick-off meetings conducted; began data collection and HIRA update
- May 2017 – HIRA draft presented to the Advisory Committee and Working Group for review and comment period (distributed electronically); revisions to draft based on comments from review period
- June 2017 – final draft HIRA delivered to VDEM
- December 2017 - Sent to FEMA (with complete draft plan) for review and approval

HIRA Section Outline

The following subsections include the results of the hazard identification and risk assessment process. The process used to identify the hazards that impact Virginia and available data sources were reviewed and endorsed by both the Advisory Committee and the Working Group.

The HIRA chapter is structured in the following way:

1. *Introduction to HIRA* – Describes the overall process that was used to revise the HIRA.
2. *Introduction to Virginia* – Describes the political, demographic, and physiographic boundaries of the Commonwealth; local and statewide land use and development patterns are addressed.
3. *Federally Declared Disasters & National Center for Environmental Information (NCEI) Hazard History* - Describes past declared disasters and hazard events that have happened in the Commonwealth; utilized datasets are fully described in this section.
4. *Commonwealth and Critical Facilities* - Describes the available datasets for state and critical facilities and the limitations of this data; local datasets are evaluated and discussed.
5. *Ranking Methodology* - Standardizes terminology, describes the development of the ranking methodology and parameters used.
6. *Local Plan Incorporation* - Review of the local hazard mitigation plan, comparison of local rankings; issues of standardization of risk assessment and loss estimates are discussed.

7. *Communicable Disease* – New hazard for this update that has the potential to impact the entre Commonwealth.
8. *Drought* - Includes discussion of the different types of drought and the criteria used for determining the severity of droughts. Drought: textual description only. Extreme Heat: textual description only.
9. *Earthquake* - Analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates.
10. *Flooding* - Flooding impacts the entire Commonwealth. Discussion of repetitive loss structures and FEMA map modernization efforts. Simplified analysis is performed using digital flood insurance rate maps (FIRMs, U.S. Census data and Benefit-Cost Analysis (BCA) assumptions.
    i. Riverine flooding: analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates.
    ii. Storm Surge: analysis of critical and state facilities. (Coastal Flooding language and references removed in this update.)
    iii. Coastal erosion: textual description only.
    iv. Storm water/Urban flooding: textual description only (new for this update).
    v. Tsunami: removed in this update due to lack of occurrence.
11. *Flooding Due to Impoundment Failure* - textual description only.
12. *Karst* - analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates.
13. *Landslide* - analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates.
14. *Land Subsidence* - associated with aquifer issues, focused on Hampton Roads area (new for this update).
15. *Non-Rotational Wind* - Distinctions in wind type were necessary to be able to determine relevant historical events and to develop methodology to calculate future probability, vulnerability and impact. Non-Rotational wind includes hurricane and all events that are not tornadic.
    i. Non-rotational Wind: analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates.
    ii. Lightning: textual description only.
    iii. Hail: textual description only.

16. *Solar Storm/Flare* - analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates (new for this update).
17. *Tornado* - analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates (separated for this update).
18. *Wildfire* - analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates.
19. *Winter Weather* - Includes discussion of different types of winter weather and the limitations of analysis.
    i. Winter Weather: analysis of critical and state facilities, jurisdictional risk, and annualized loss estimates. Extreme Cold: textual description only.
20. *Summary* - Provides a summarization of the individual hazard sections. Overall conclusions regarding risk areas and mitigation projects.

For the purposes of compliance with the Disaster Mitigation Act of 2000 (DMA2K) as further specified by 44 CFR, §206.401(c)(2)(i), this Plan addresses in full only the hazards in the above hazard identification sub-section. Additional hazards may be more fully addressed during future updates as their respective significance emerges. Additional information is available in section 3.6 of this chapter. Technological, radiological, hazardous materials, and terrorism-related hazards are addressed in Hazard Specific Annexes of the COVEOP. This plan revision also analyzes critical infrastructure impacts resulting from natural hazards with the goal of adding more critical infrastructure in future updates. In addition, as a requirement of Presidential Preparedness Directive 8 (PPD-8), a Threat Hazard Identification and Risk Assessment (THIRA) has been developed and was used as a reference document for this plan update.

Changes in this Version

The risk assessment in this plan updates content from the 2013 SHMP. For all previously included hazards, content has been updated to include new data from hazard events which have occurred since the 2013 SHMP, as well as an updated ranking methodology. For all new hazards, content has been developed to mirror previously included content.

Section 3.2: Introduction to Virginia

Virginia is located on the Mid-Atlantic coast of the continental US. Virginia displays a unique geography including the Appalachian and Blue Ridge Mountains to the west and northwest, piedmont in central and south-central Virginia, and the coastal plain area east of the Interstate-95 corridor. The eastern portion of the state is adjacent to the Chesapeake Bay and Atlantic Ocean, which offer unique economic opportunities as well as emergency management challenges. The shaded relief map in Figure 3.2-1 illustrates the major physiographic features of Virginia.

Several major watersheds are found in the state, as shown in Figure 3.2-2. Most of the streams and rivers in northern and central Virginia flow east towards the Chesapeake Bay. The southeastern and central southern parts of the state drain through North Carolina directly into the Atlantic Ocean. The southwestern portion of the state drains into the Mississippi River and Gulf of Mexico via the Holston, Clinch-Powell, New, and Big Sandy rivers.

The climate of Virginia is moderate with four well-defined seasons. Daytime temperatures usually range from 30° F in the winter to 90° F in the summer, although historic temperature extremes above 100° F, and below 0° F, have been observed with the higher temperatures more common on an annual basis. On average, the coastal region is the warmest due to maritime influences, with temperatures gradually decreasing across the Piedmont towards the west. The climate of the western part of the state, which reaches a maximum elevation of 5,729’ above sea level at Mount Rogers, is significantly cooler on average throughout the year.

Figure 3.2-3 shows the 95 counties and 38 independent cities that make up the Commonwealth of Virginia. The national capital, Washington, D.C., is located on the Potomac River at Virginia’s northern border with Maryland. The state capitol is the City of Richmond. Unlike most other states, cities and counties in Virginia are each independent political jurisdictions.

As of 2016, there are also 190 incorporated towns in the Commonwealth of Virginia. An incorporated town in Virginia is the equivalent to a city in most other states.

Additionally, as of this plan update, Virginia is home to a federally-recognized Tribal Nation, the Pamunkey Indian Tribe. Consisting of about 200 members, with tribal lands in King William County, the Pamunkey Nation is the first federally-recognized tribe in the Commonwealth[1].

The cities and counties in Virginia are also organized into 21 Planning District Commissions (PDCs), as shown in Figure 3.2-4. These commissions provide a platform for regional planning and communication on a variety of subjects, such as land use planning, transportation, and

economic development. The PDCs have little governing authority beyond the will of their constituent local governments. Each of the 20 local hazard mitigation plans in the Commonwealth of Virginia were completed on a regional basis through PDCs (some PDCs combine resources to create and maintain their local hazard mitigation plan).

The cities and counties are also organized into regions by the Virginia Department of Emergency Management (VDEM). This administrative organization allows for ease of planning, training, exercises, and grant management. Figure 3.2-5 shows the VDEM Regions.

The first known residents of present-day Virginia were Native Americans, whose ancestors arrived in North America thousands of years ago. In the late 1500s and early 1600s, Europeans began to sail across the Atlantic Ocean, exploring and colonizing Virginia. The first lasting English settlement in Virginia, dating to 1607, was located at Jamestown. As colonization of the Americas progressed, Virginia grew into an important center of trade and government. Many Virginians were notable figures in the American Revolution, and many of the early Presidents were native Virginians. In 1861, Virginia seceded from the union and Richmond became the capitol of the Confederate States of America, and was the site of many battlegrounds in the subsequent American Civil War. Following the reunification of the US, Virginia continued to develop, with many large urban areas in the eastern and northern parts of the state. Today, Virginia's culture reflects a mixture of the old and new, urban and rural.

Figure 3.2-1: Shaded Relief of Virginia[2]

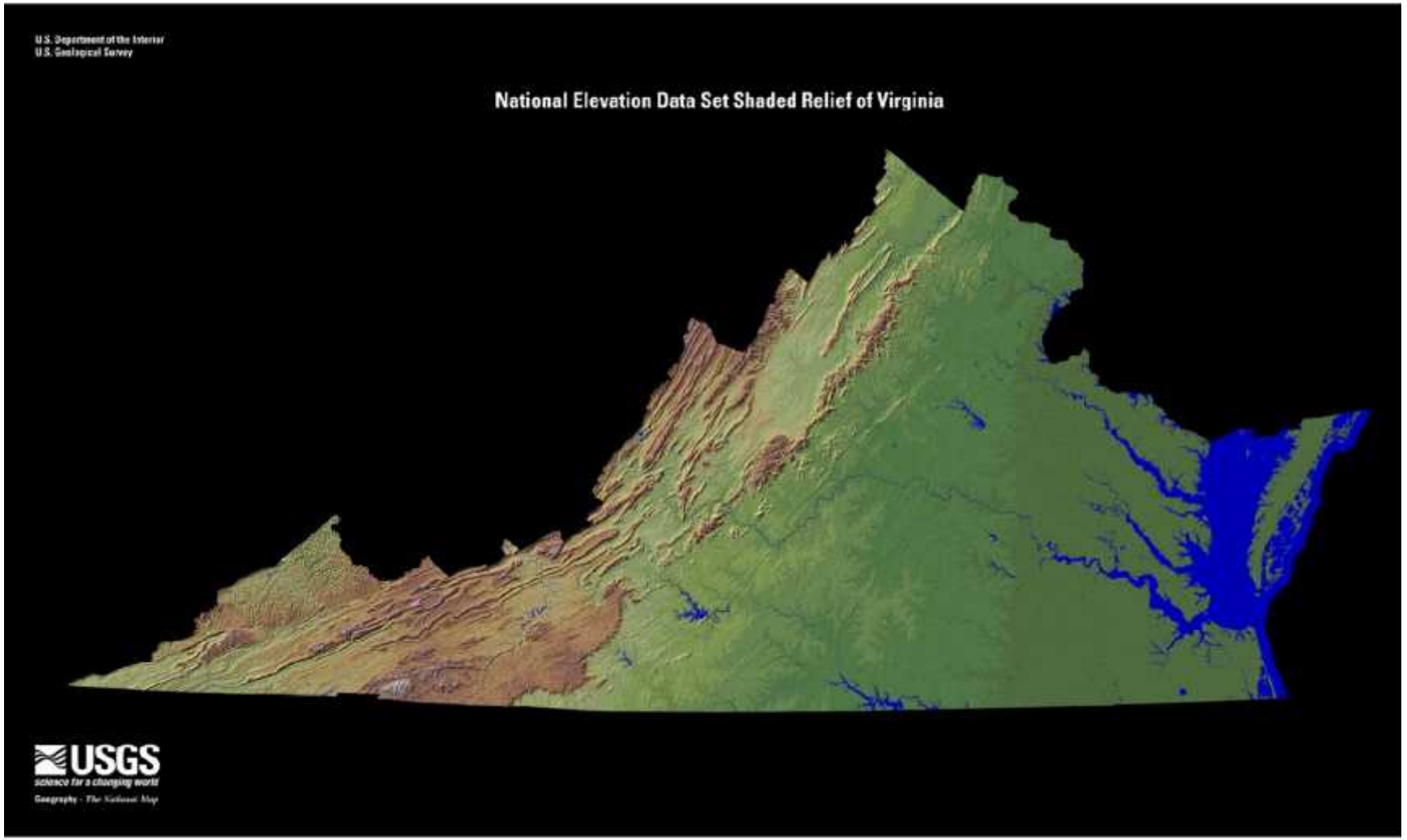


Figure 3.2-2: Watersheds of Virginia[3]

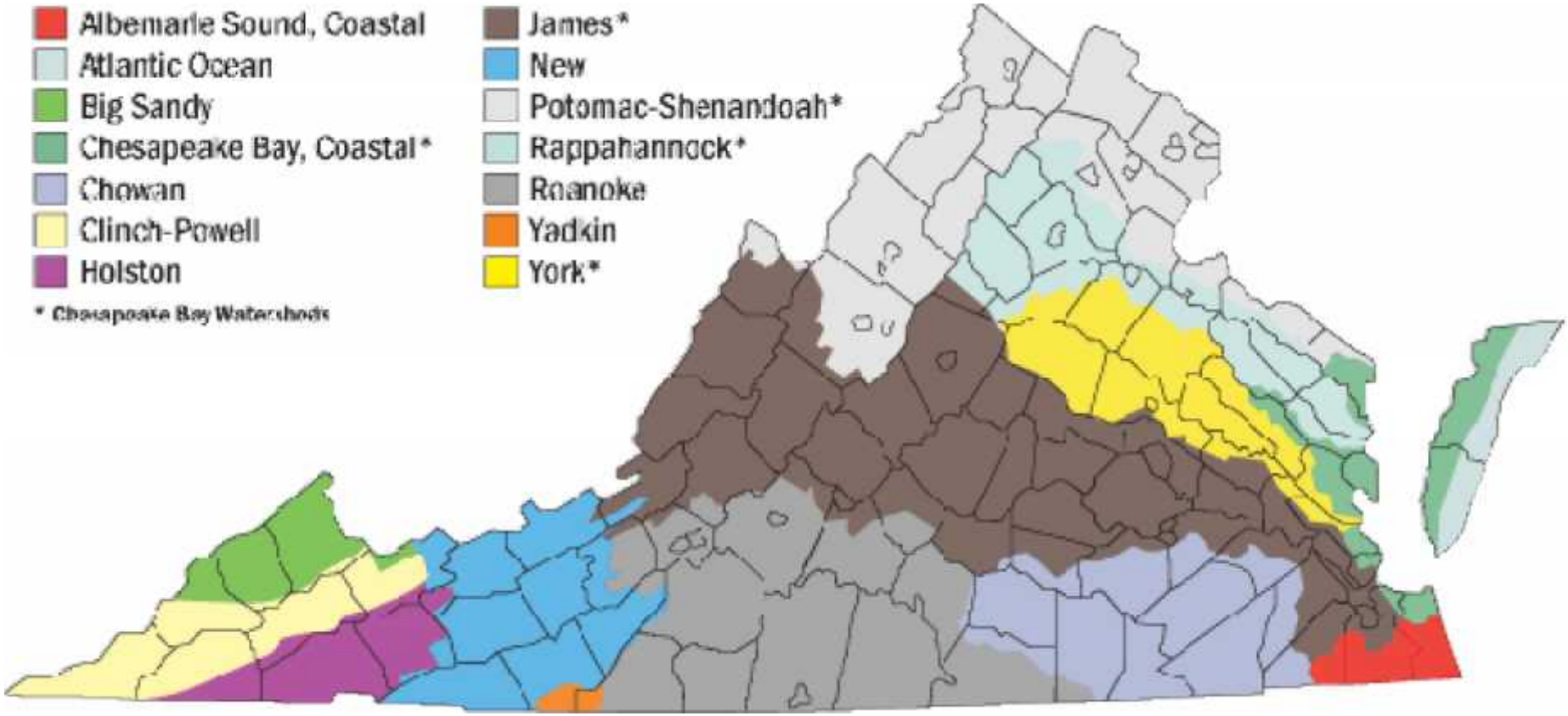


Figure 3.2-3: Municipalities in Virginia[4]

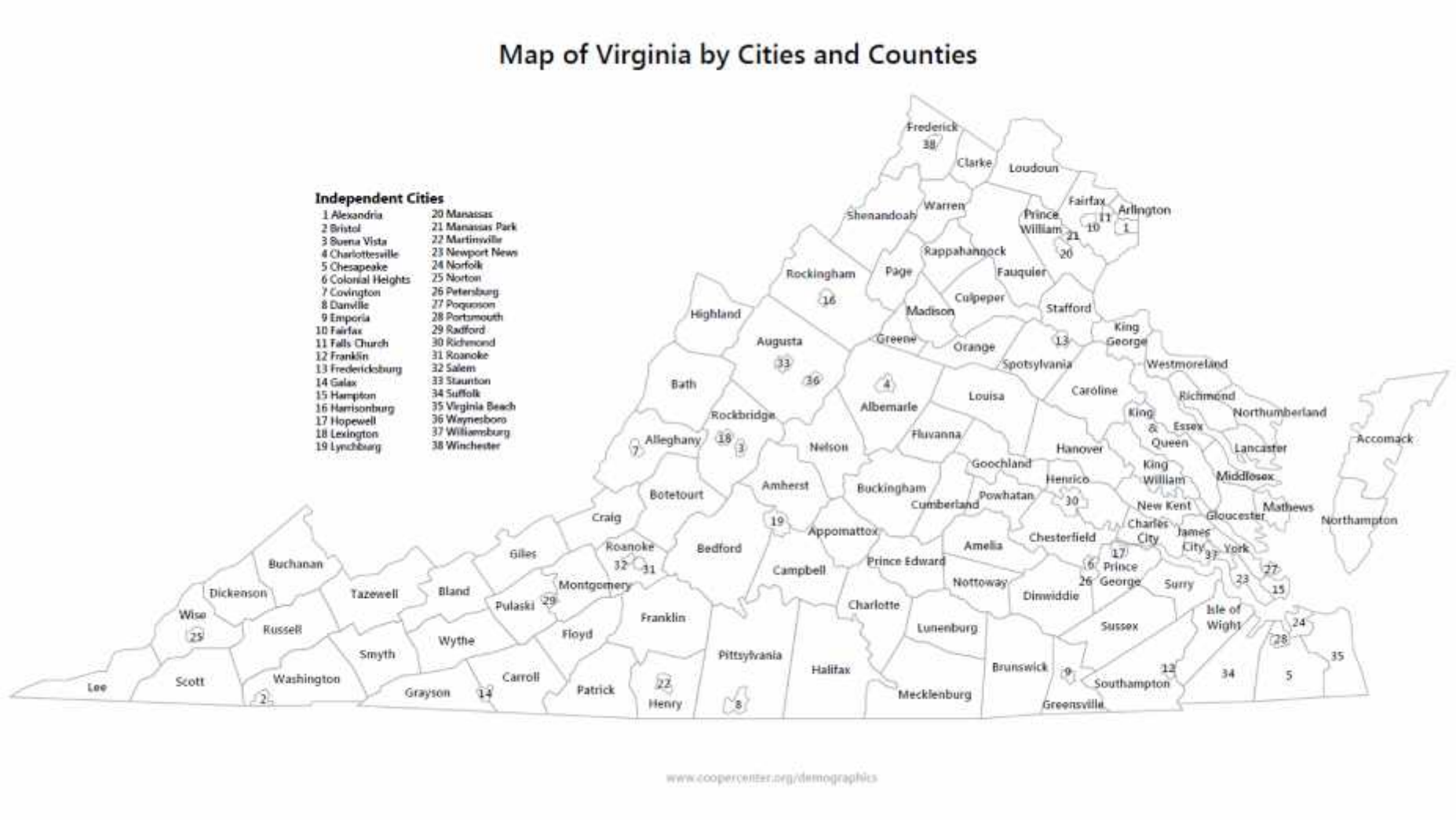
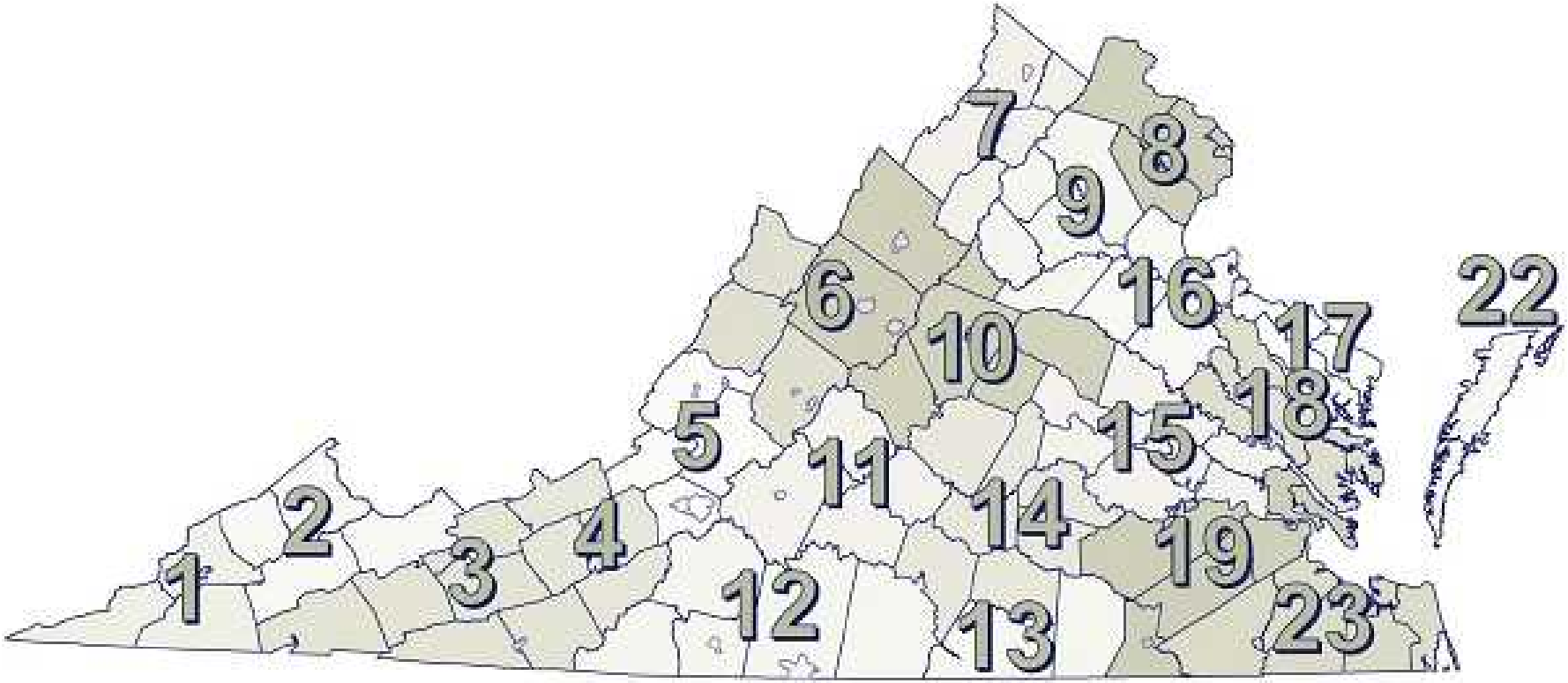


Figure 3.2-4: Planning District Commissions[5]



Listing of PDCs in Virginia[6]*:*

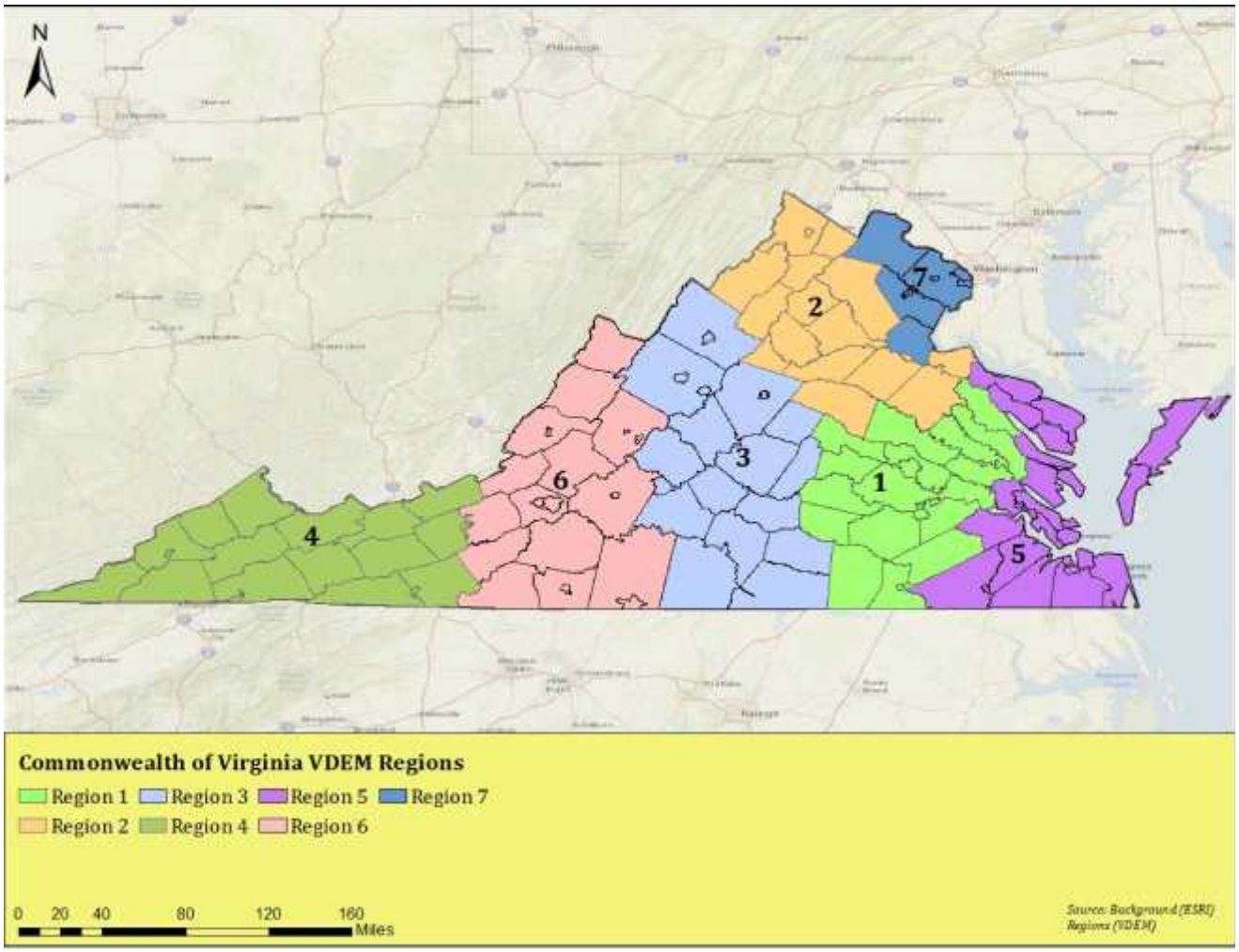
01 – LENOWISCO Planning District Commission
02 – Cumberland Plateau Planning District Commission
03 – Mount Rogers Planning District Commission
04 – New River Valley Regional Commission
05 – Roanoke Valley-Alleghany Regional Commission
06 – Central Shenandoah Planning District Commission
07 – Northern Shenandoah Valley Regional Commission
08 – Northern Virginia Regional Commission
09 – Rappahannock-Rapidan Regional Commission
10 – Thomas Jefferson Planning District Commission
11 – Region 2000 Local Government Council
12 – West Piedmont Planning District Commission
13 – Southside Planning District Commission
14 – Commonwealth Regional Commission
15 – Richmond Regional Planning District Commission
16 – George Washington Regional Commission
17 – Northern Neck Planning District Commission
18 – Middle Peninsula Planning District Commission
19 – Crater Planning District Commission
22 – Accomack-Northampton Planning District Commission
23 – Hampton Roads Planning District Commission

(Note: There is no number 20 or 21.)

The Richmond Regional PDC and the Crater PDC share Chesterfield County and Charles City County. The Middle Peninsula PDC and the Hampton Roads PDC share Gloucester County. The Crater PDC and the Hampton Roads PDC share Surry County. The Roanoke Valley-Alleghany Regional Commission and the West Piedmont PDC share Franklin County.

Nottoway and Cumberland Counties do not belong to a PDC.

Figure 3.2-5: VDEM Regions[7]



Demographics

Virginia's demographics are a major factor in the risk posed by natural hazards. Per the US Census, the population of Virginia was over 8.3 million in 2016, making it the 12th most populous state in the nation[8]. Most residents live in the eastern part of the state, along the corridor running from Washington, D.C. to Virginia Beach known as the Golden Crescent. A great deal of the state's economy is driven by activity in urban areas of northern and eastern Virginia; in recent years, Fairfax and Loudon counties in Northern Virginia have routinely been ranked at or near the top in nationwide comparisons of household income. The remainder of the state is largely rural, with several smaller urban areas. Figure 3.2-6 shows the population distribution in the Commonwealth based on the 2010 Census.

The overall population of Virginia continues to increase annually, although the rate of growth has declined somewhat in the past few years. Approximately half of Virginia's population growth since 2000 can be attributed to natural increase; that is, population growth that occurs when the birthrate exceeds the death rate. Immigration from other states and foreign countries accounts for the other half of the state's population growth. More than 70% of Virginians live in the Northern Virginia, Richmond, and Hampton Roads regions. Population trends show uneven change throughout the state. Figure 3.2-7 shows the population change since the 2010 Census, as calculated by the Demographics Research Group at the University of Virginia[9]. Table 3.2-1 shows the top ten jurisdictions, in terms of percent population change, between 2010 and 2015.

Table 3.2-1: Top 10 Jurisdiction with the Highest Growth Rates (2010 – 2015) based on US Census Population Data[10]

Jurisdiction	2010 Population	2015 Population	% Population Change
Loudoun County	312,311	375,629	20.3%
Fredericksburg (city)	24,286	28,118	17.0%
Falls Church (city)	12,332	13,892	13.0%
Prince William County	402,002	451,721	12.4%
New Kent County	18,429	20,392	10.6%
Manassas Park (city)	14,273	15,726	10.4%
Arlington County	207,627	229,164	10.3%
Stafford County	128,961	142,003	10.1%
Williamsburg (city)	14,068	15,052	10.1%
Alexandria (city)	139,966	153,511	9.6%

The US Census Bureau's Population Division estimates that the population of Virginia will continue increasing, with most growth occurring in the form of urban sprawl. The population

of Fairfax County has exceeded 1 million and is expected to grow over 14% from 2020 through 2040[11]. The following jurisdictions are projected to have greater than 25% population growth (2020 – 2040)[12]:

- Loudoun County (36%)
- Prince William County (29%)
- James City County (27%)
- City of Manassas Park (27%)
- Stafford County (27%)
- New Kent County (27%)
- King George County (27%)
- Culpeper County (25%)
- Spotsylvania County (25%)
- City of Suffolk (25%)

Population decline appears most in the rural counties of Virginia. Table 3.2-2 shows the 10 jurisdictions with the largest population decline for the years 2010 through 2015[13].

Table 3.2-2: Jurisdiction with Declining Populations (2010-2015) based on US Census Population Data[14]

Jurisdiction	2010 Population	2015 Population	% Population Change
Emporia (city)	5,927	5,496	-7.3%
Buchanan County	24,098	22,776	-5.5%
Bath County	4,731	4,470	-5.4%
Covington (city)	5,961	5,658	-5.0%
Mecklenburg County	32,727	31,081	-5.0%
Surry County	7,058	6,709	-5.0%
Dickenson County	15,903	15,115	-4.9%
Lunenburg County	12,914	12,299	-4.8%
Tazewell County	45,078	42,899	-4.8%
Highland County	2,3321	2,214	-4.5%

Jurisdictions projected to have a decline in population (greater than 15%) between 2020 and 2040 include[15]:

- Buchanan County (-35%)
- City of Martinsville (-28%)
- Accomack County (-26%)
- City of Danville (-26%)
- Highland County (-21%)
- Alleghany County (-21%)
- Grayson County (-20%)
- Henry County (-18%)
- Brunswick County (-16%)

Figure 3.2-6: 2010 Population Distribution[16]

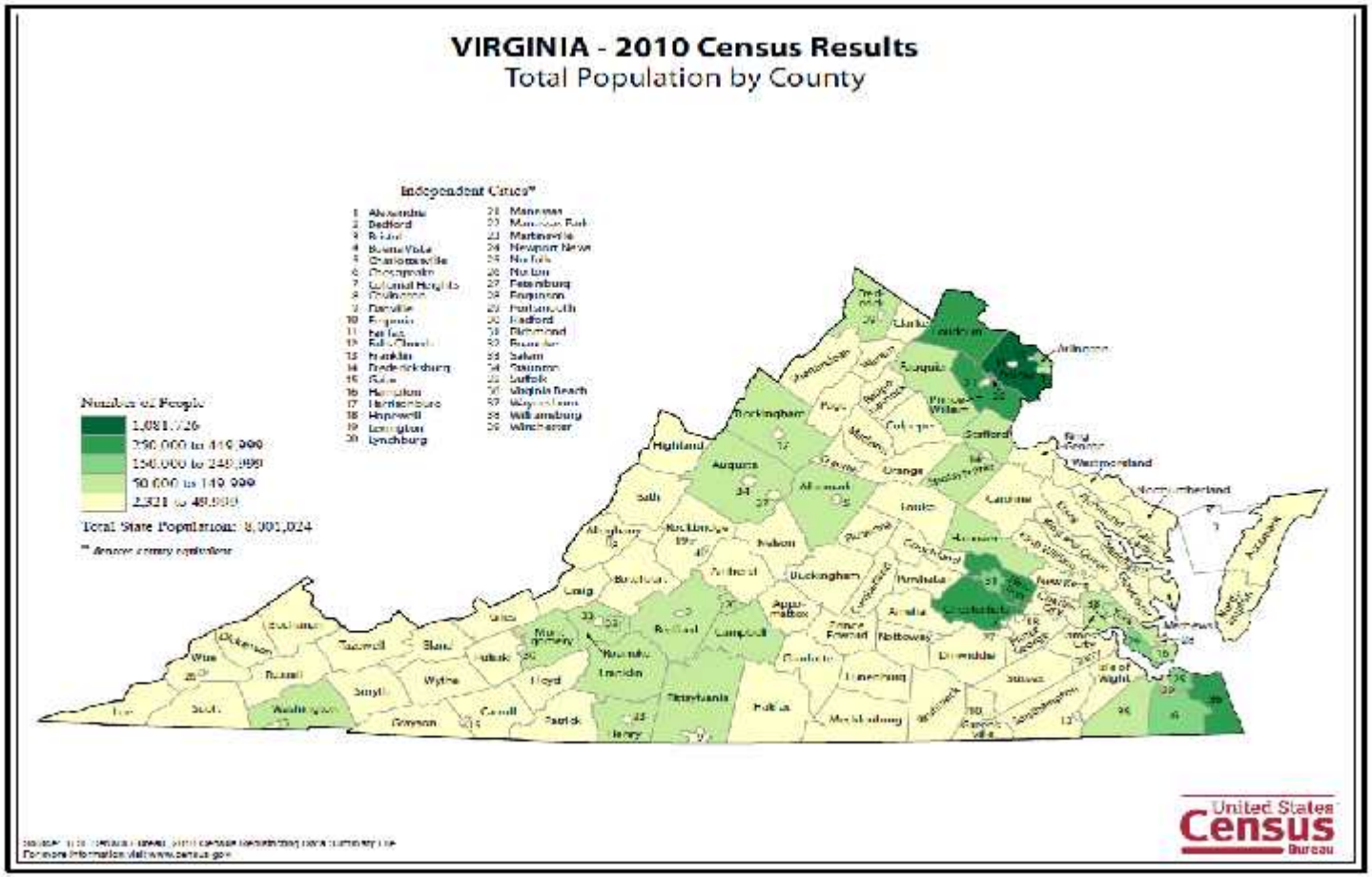
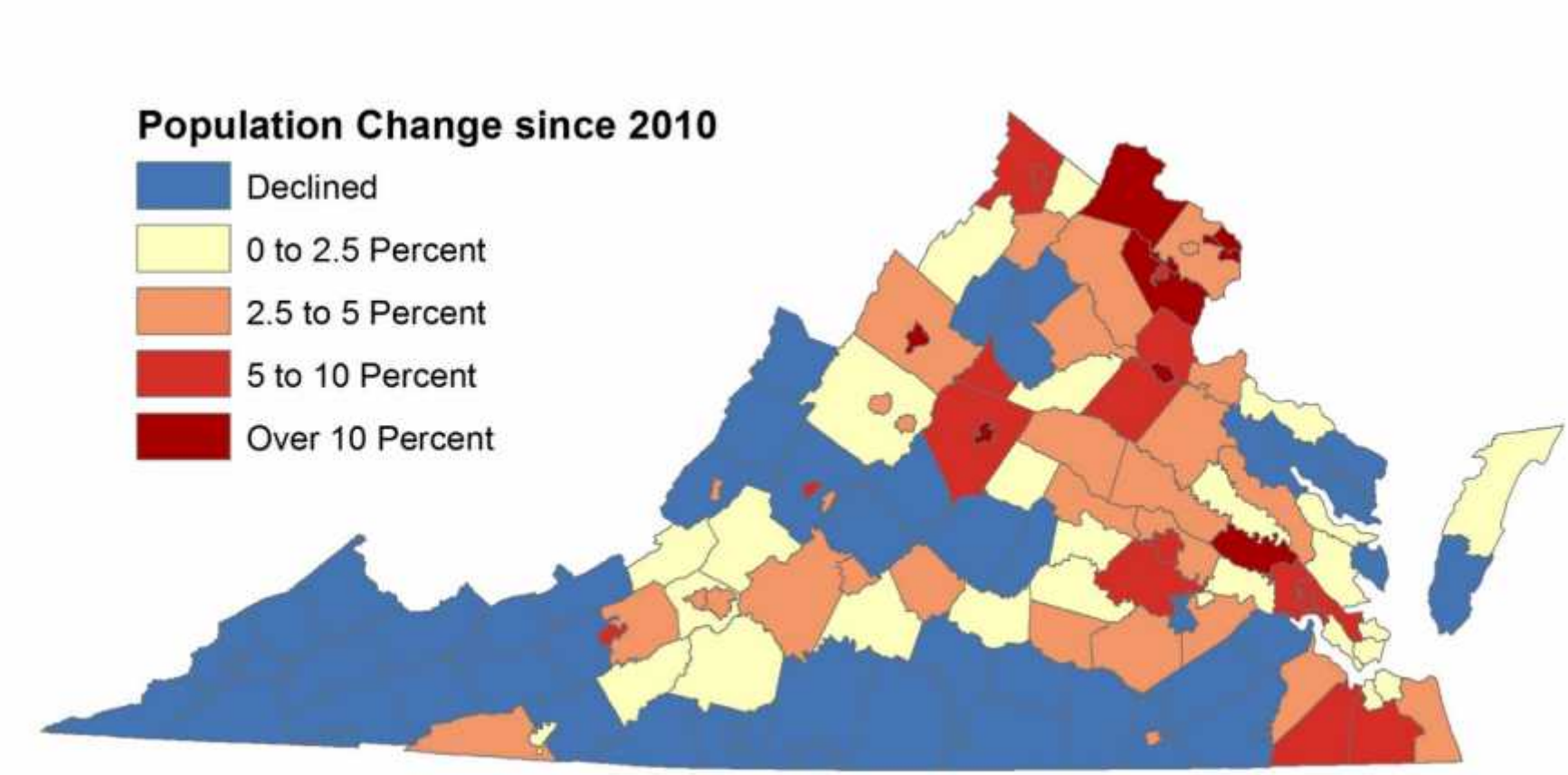


Figure 3.2-7: Population Change Since 2010[17]



Land Use, Cover, and Development

In evaluating both hazards and future conditions, it is important to note the land use trends that are present in Virginia. Urbanization is particularly important, and mirrors the trends in population change throughout the state. Data showing land use/land cover changes in the US is readily available for certain time periods. The Multi-resolution Land Characteristics Consortium (MRLC) has assessed land use/land cover over the entire US based on satellite imagery; this is known as the National Land Cover Database (NLCD). The MRLC has produced a land cover change analysis between 2001 and 2011 (the most recent year of analysis offered), in the form a raster image with pixel values representing the change of one land use to another. Figure 3.2-8 shows the statewide land use trends, based on the MRLC's data. Figures 3.2-9 through 3.2-15 show the land use trends by VDEM region. Figure 3.2-16 shows the land cover in Virginia; Figures 3.2-17 through 3.2-23 show the land cover by VDEM region.

Figure 3.2-8: Land Use in Virginia

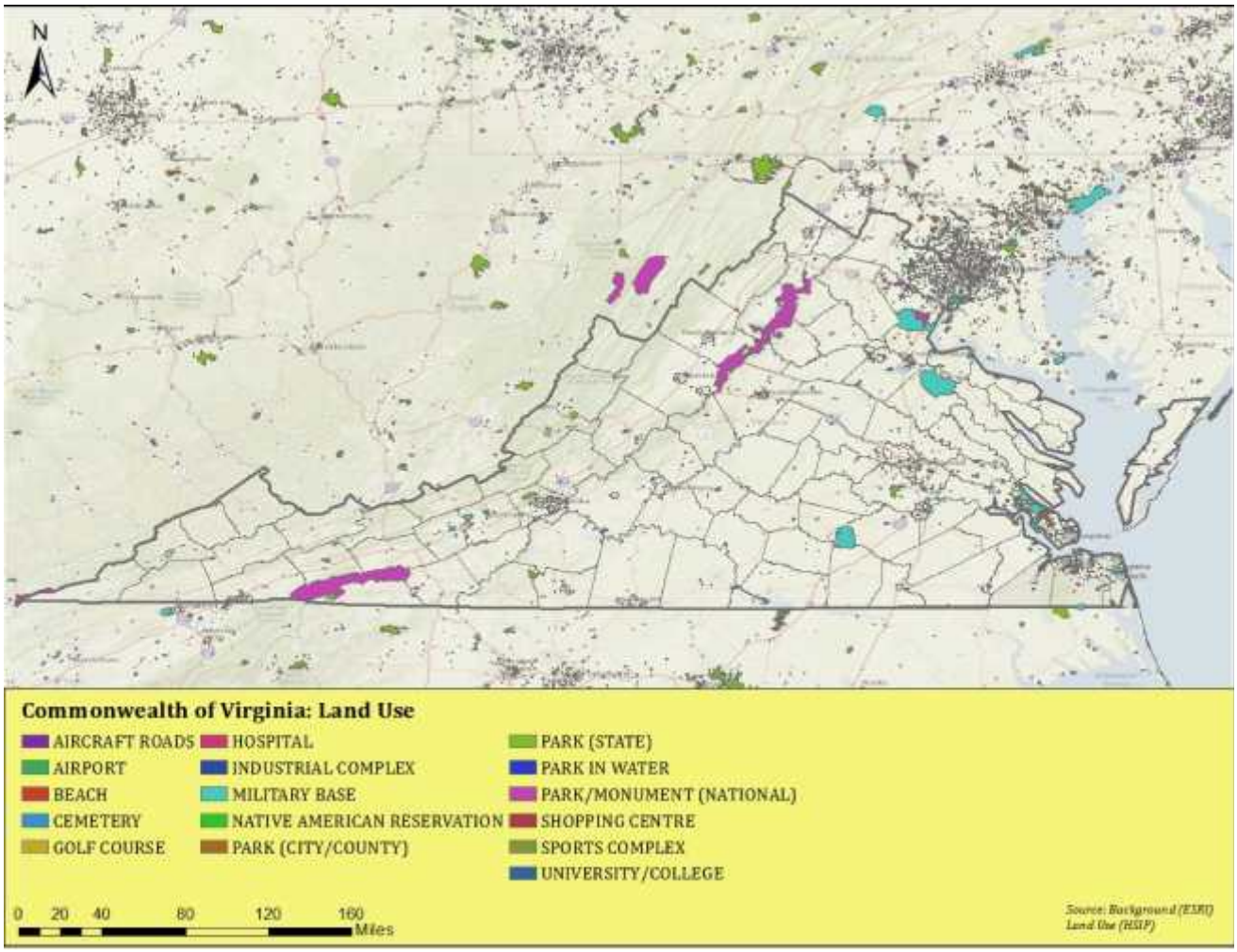


Figure 3.2-9: Land Use in Virginia – VDEM Region 1

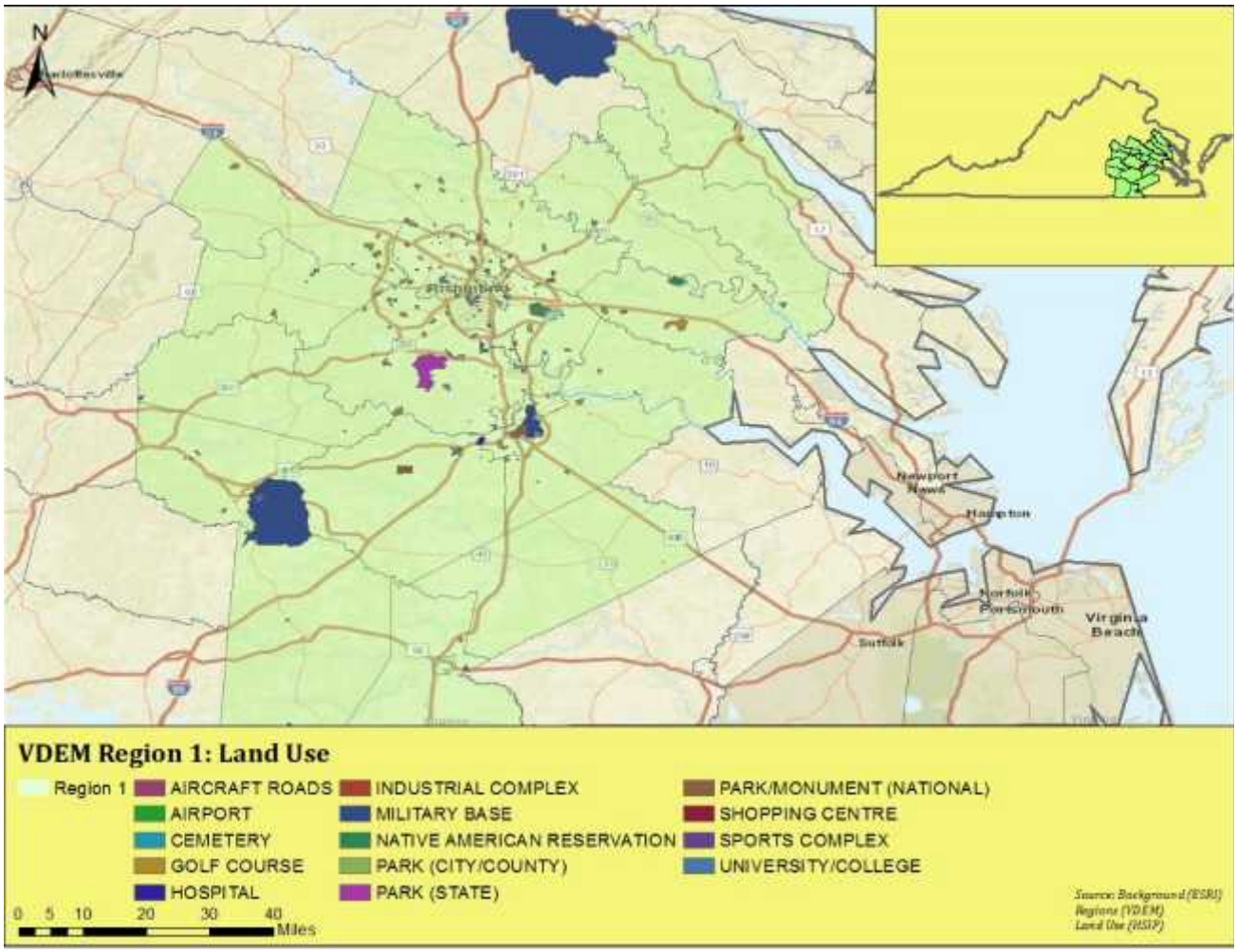


Figure 3.2-10: Land Use in Virginia – VDEM Region 2

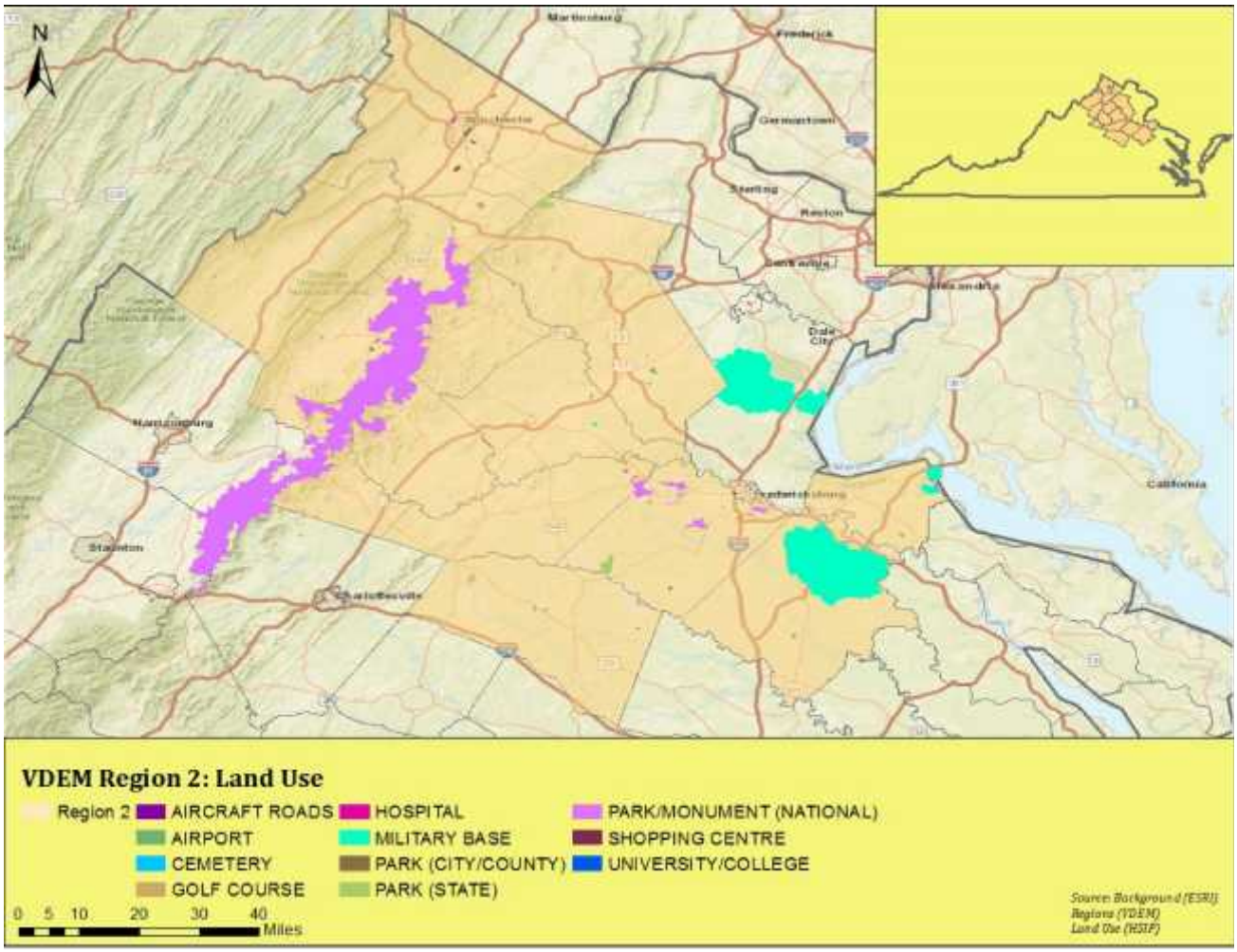


Figure 3.2-11: Land Use in Virginia – VDEM Region 3

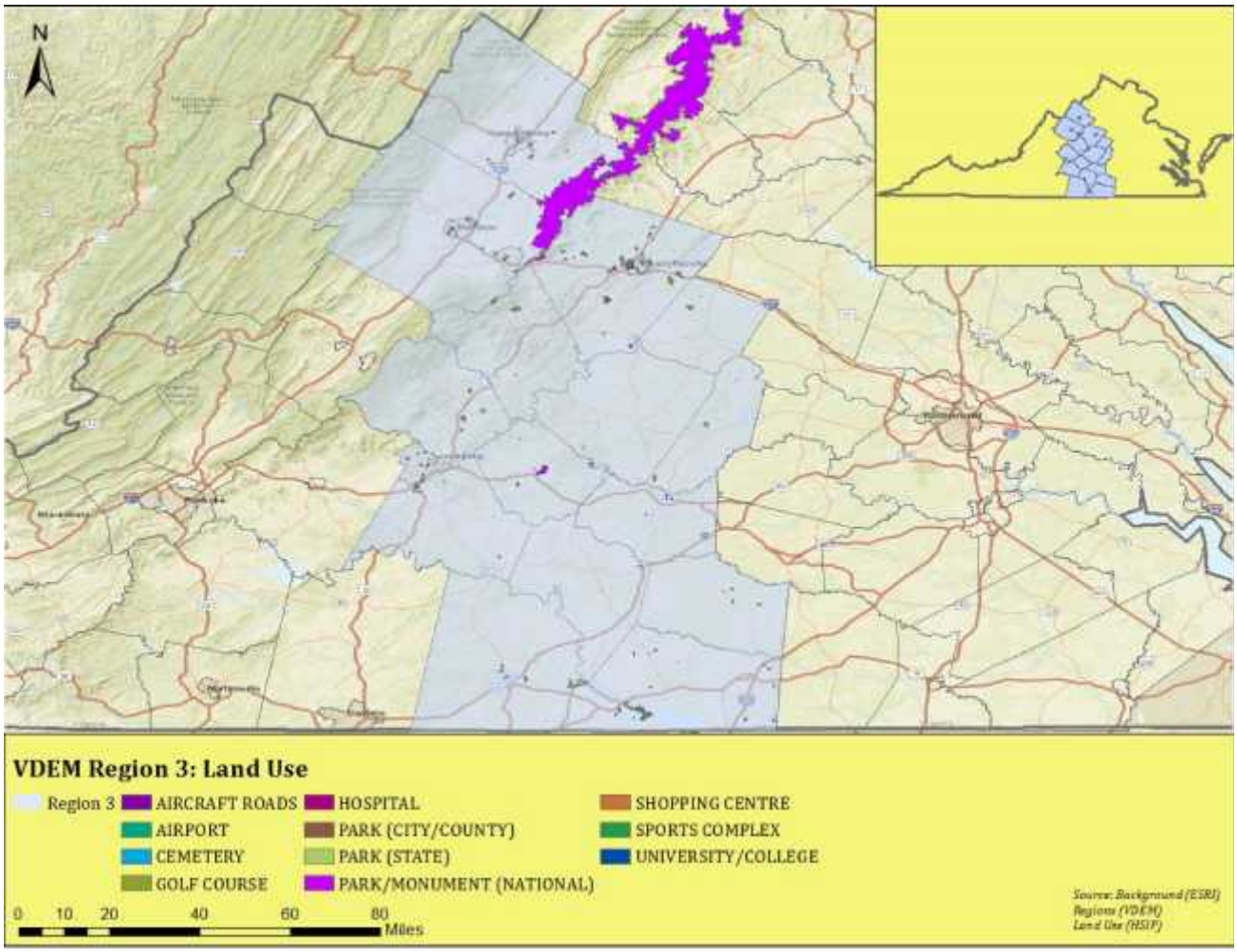


Figure 3.2-12: Land Use in Virginia – VDEM Region 4

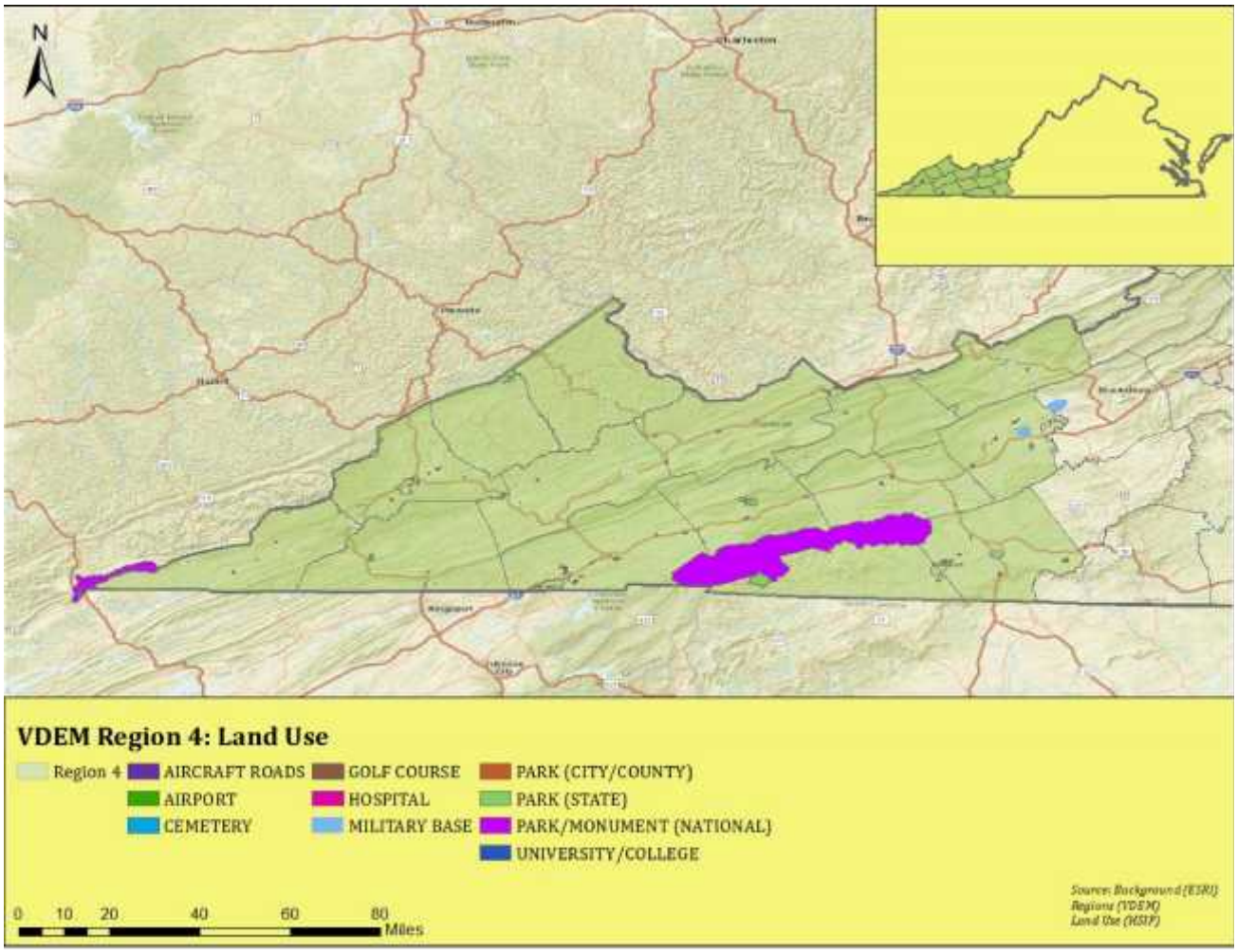


Figure 3.2-13: Land Use in Virginia – VDEM Region 5

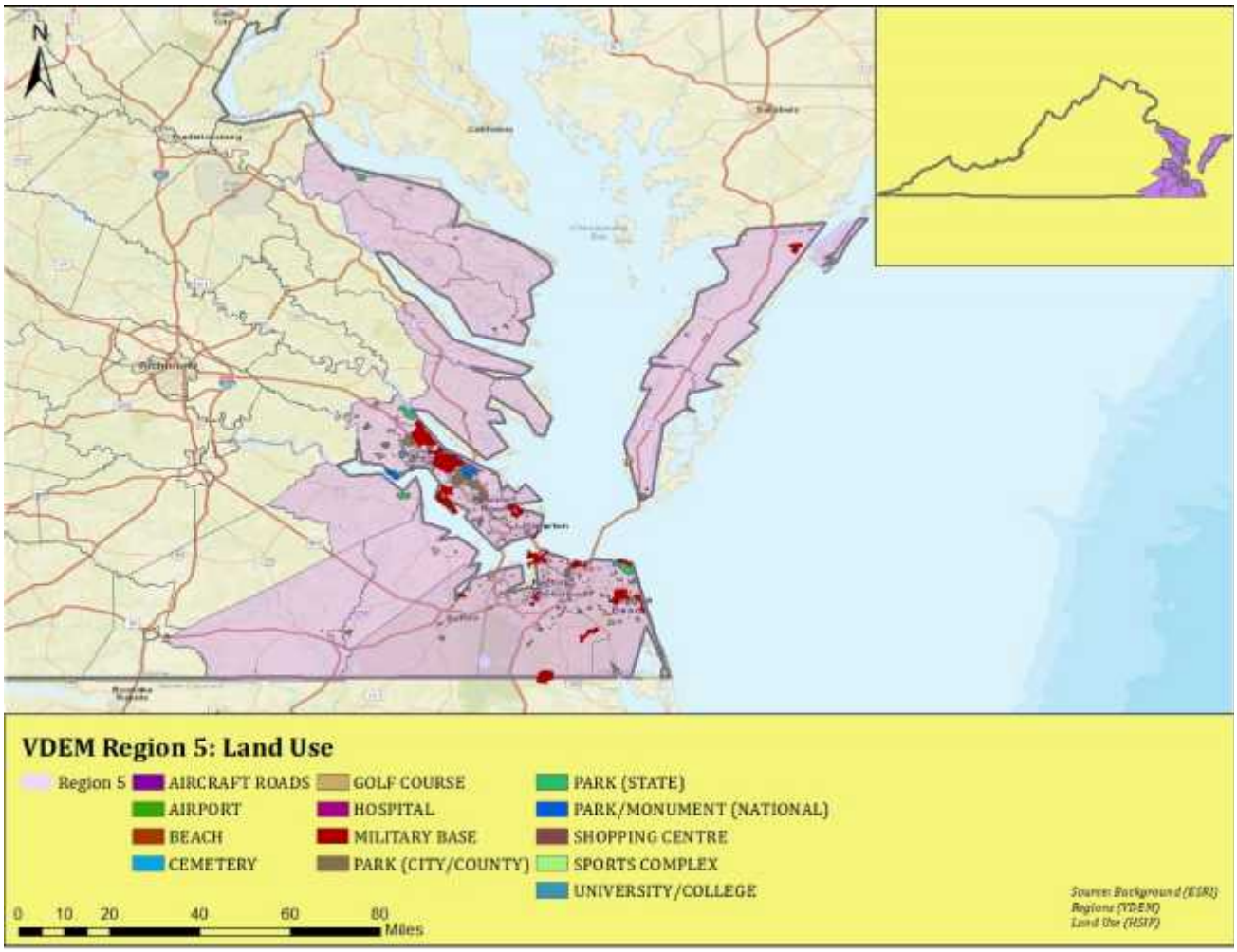


Figure 3.2-14: Land Use in Virginia – VDEM Region 6

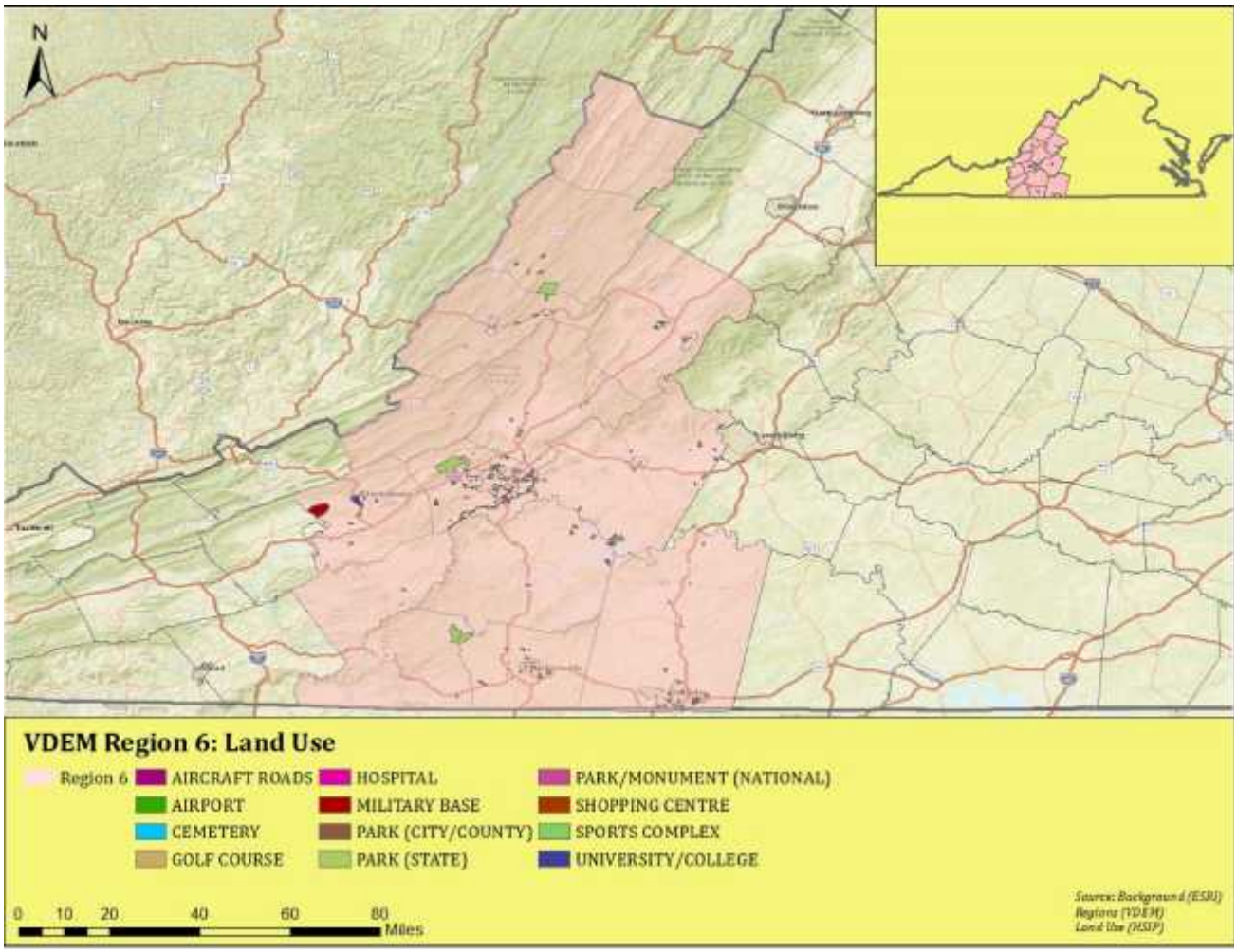


Figure 3.2-15: Land Use in Virginia – VDEM Region 7

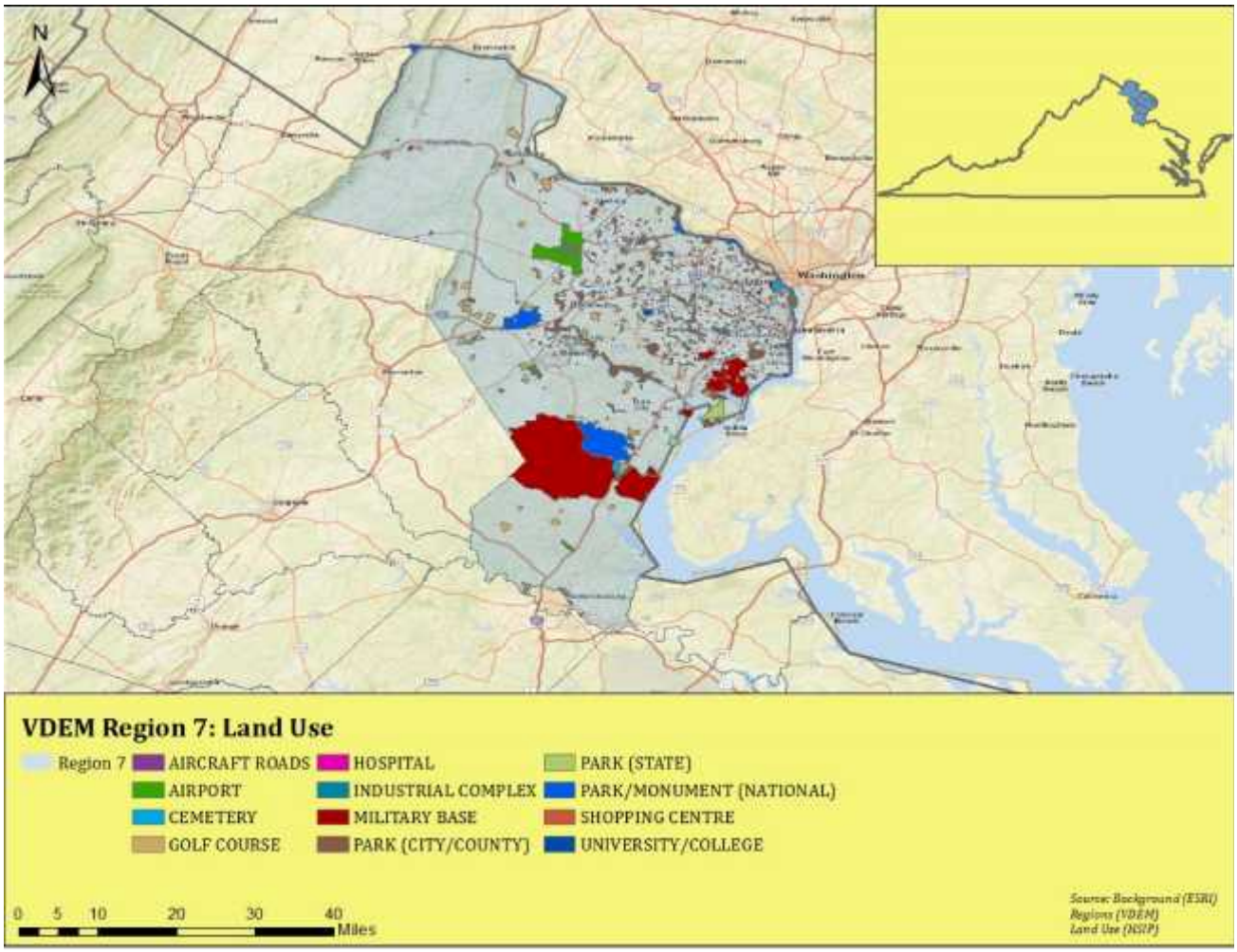


Figure 3.2-16: Land Cover in Virginia

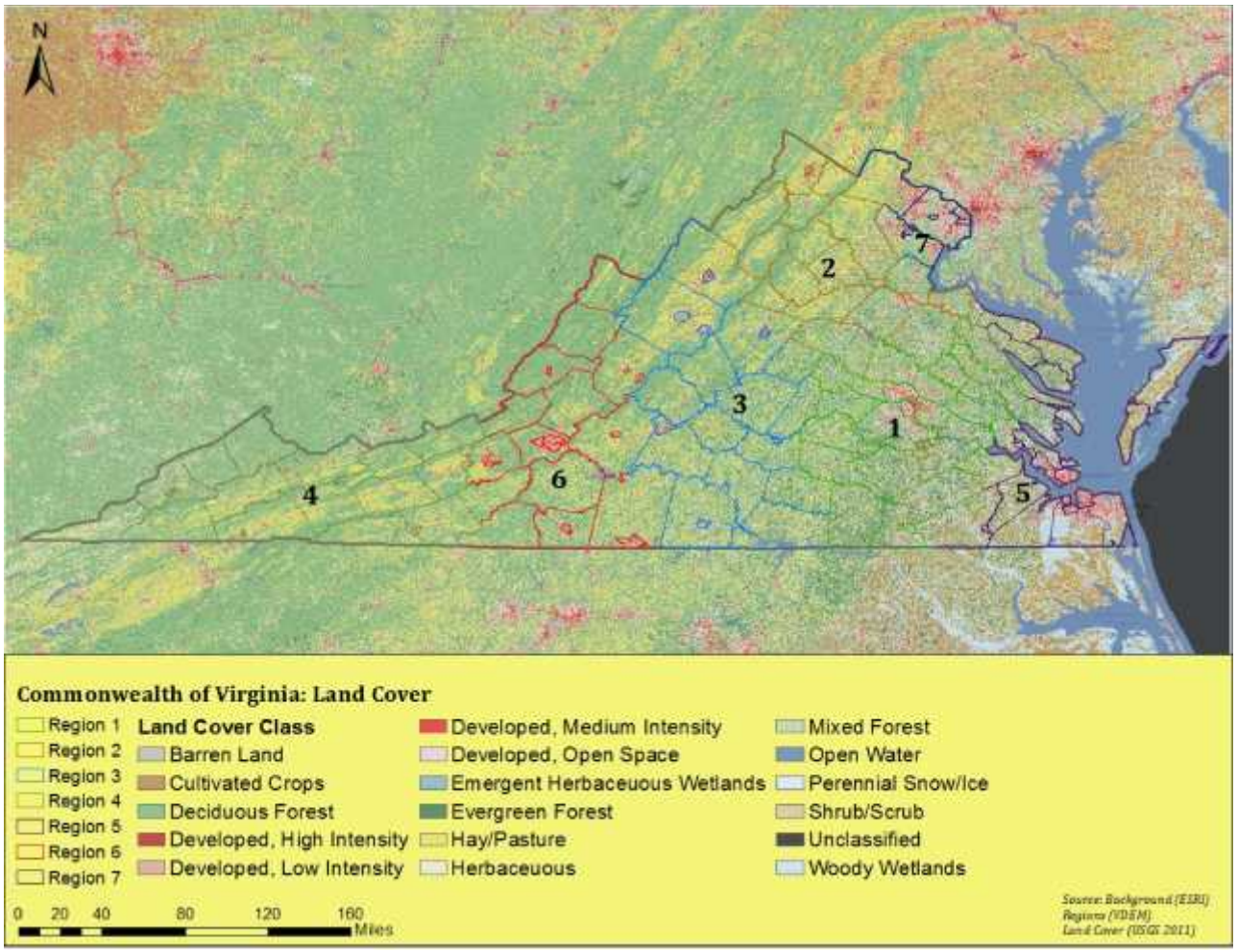


Figure 3.2-17: Land Cover in Virginia – VDEM Region 1

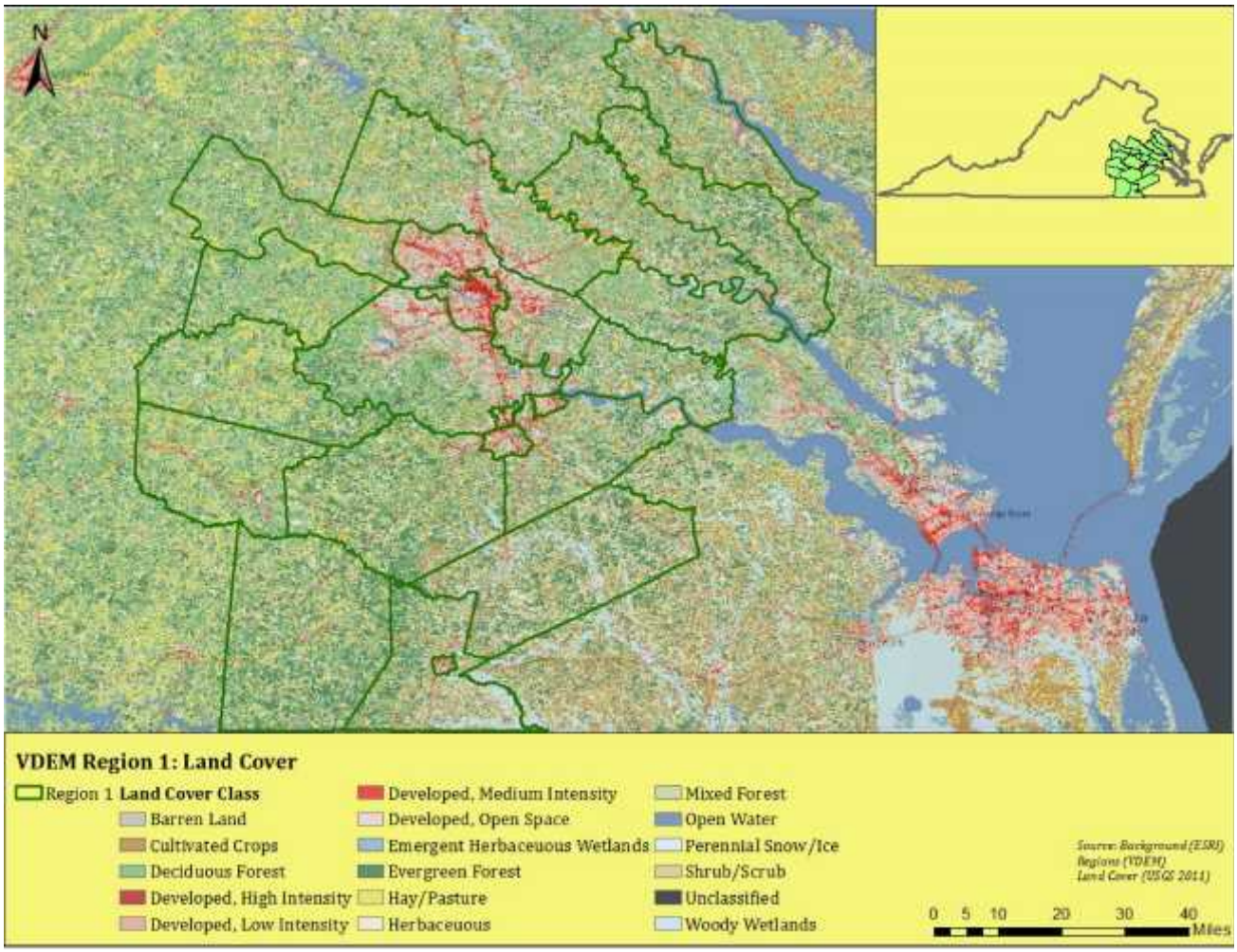


Figure 3.2-18: Land Cover in Virginia – VDEM Region 2

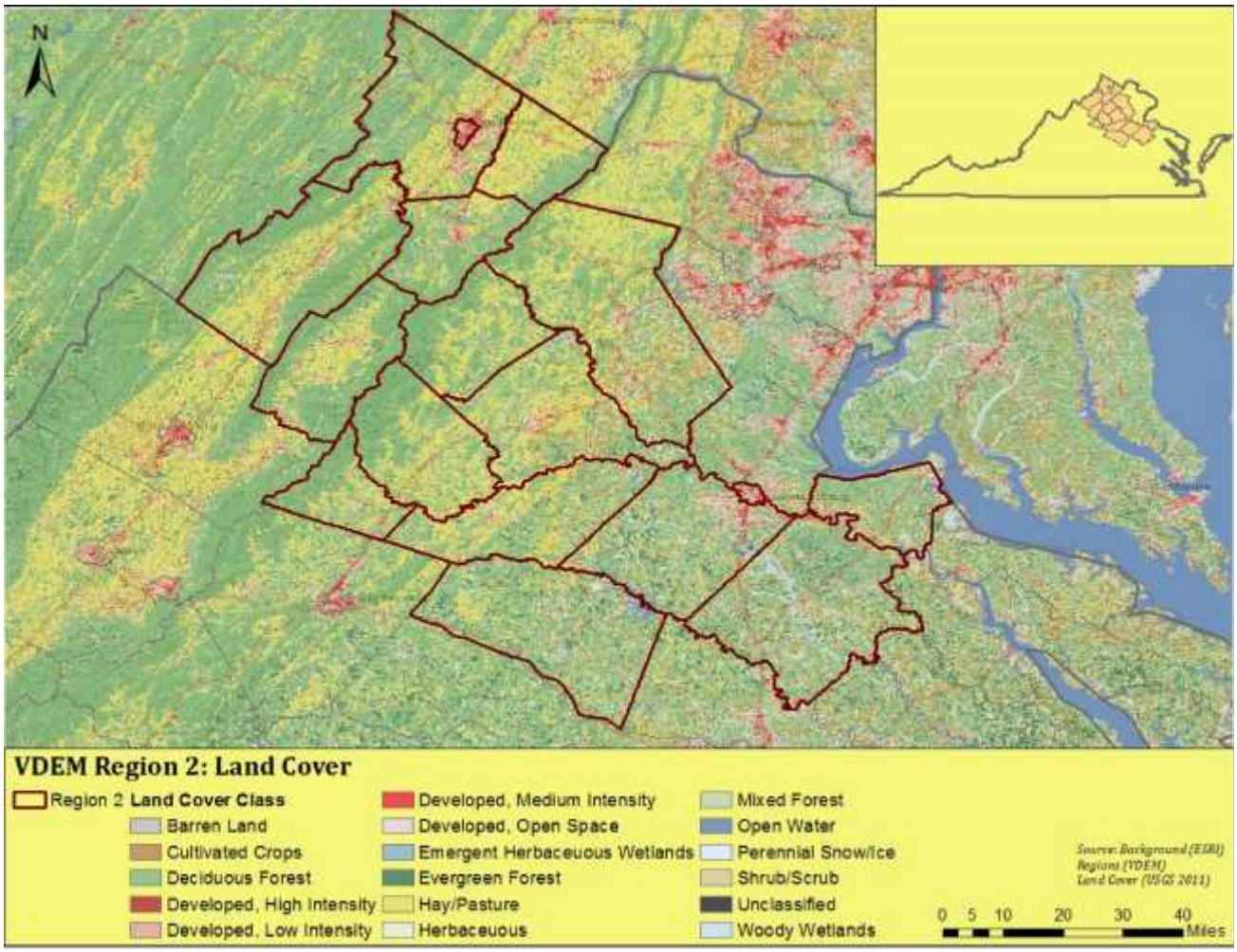


Figure 3.2-19: Land Cover in Virginia – VDEM Region 3

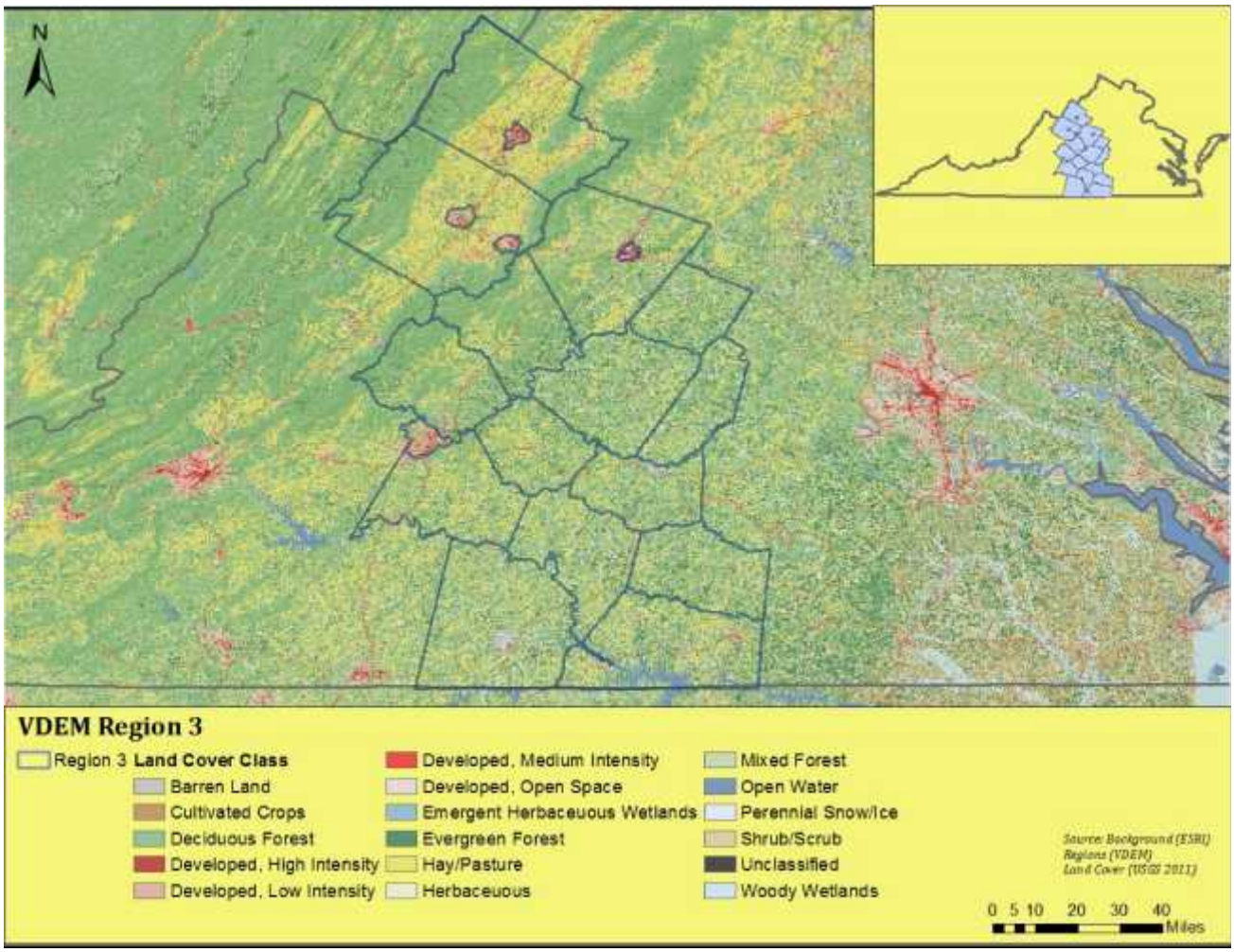


Figure 3.2-20: Land Cover in Virginia – VDEM Region 4

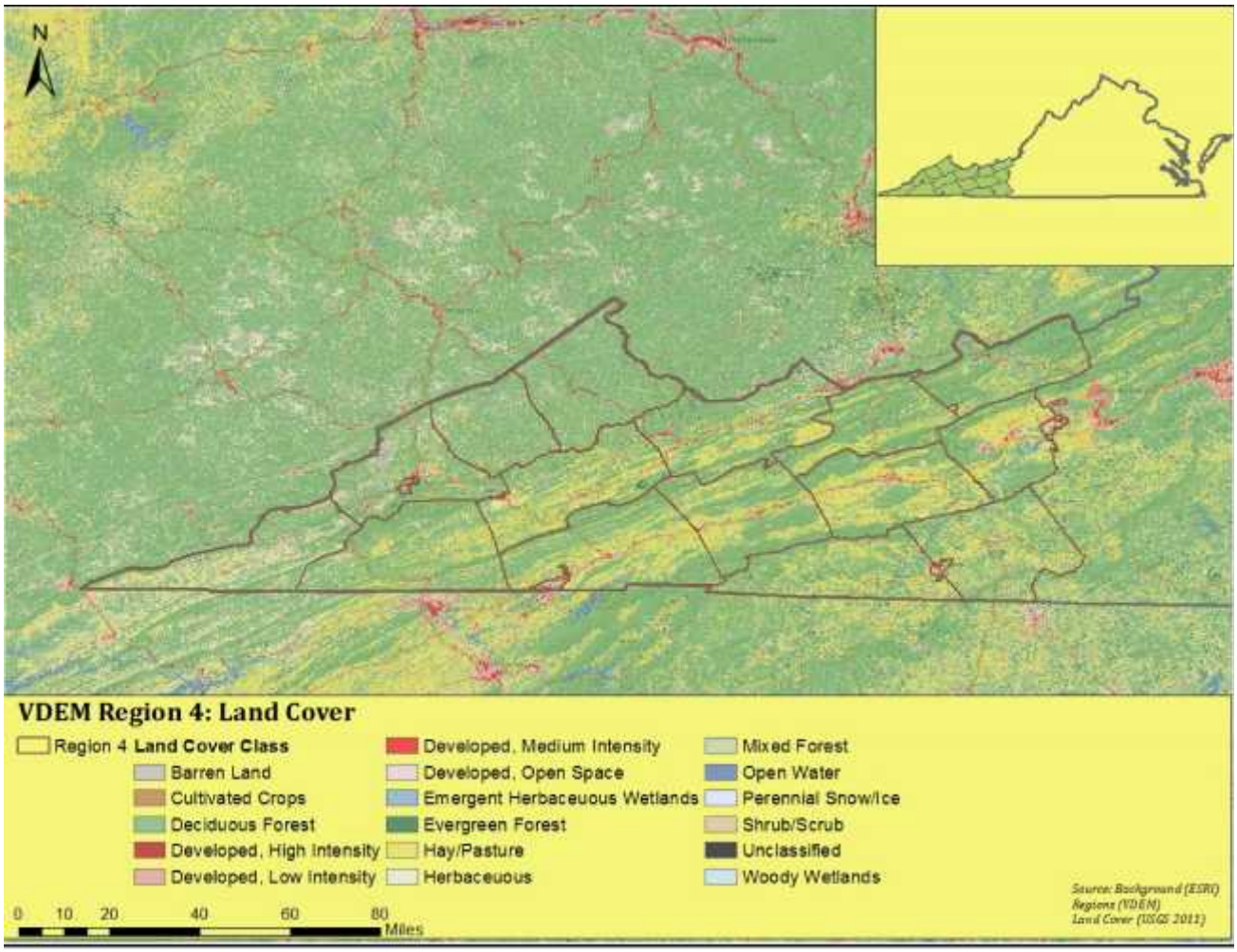


Figure 3.2-21: Land Cover in Virginia – VDEM Region 5

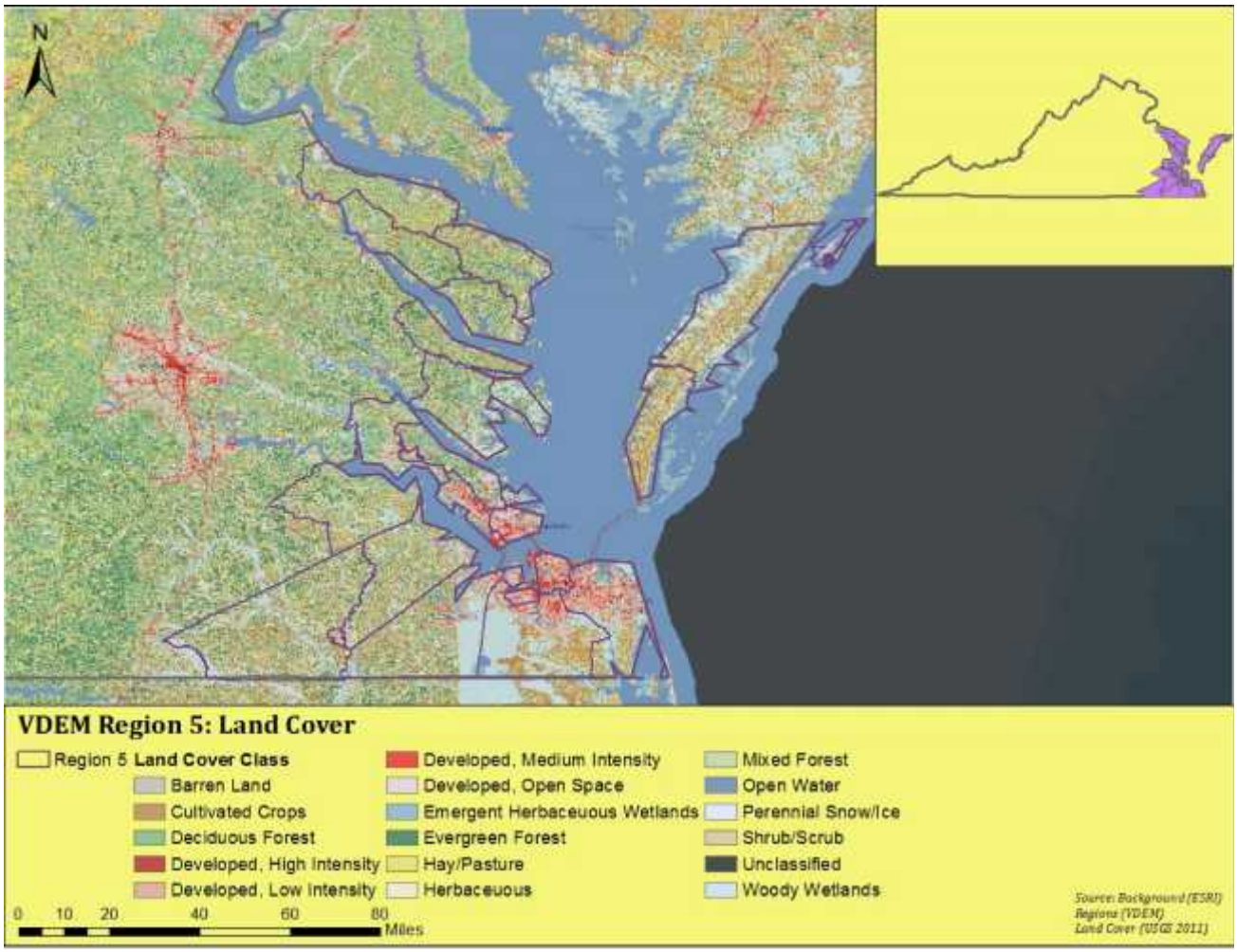


Figure 3.2-22: Land Cover in Virginia – VDEM Region 6

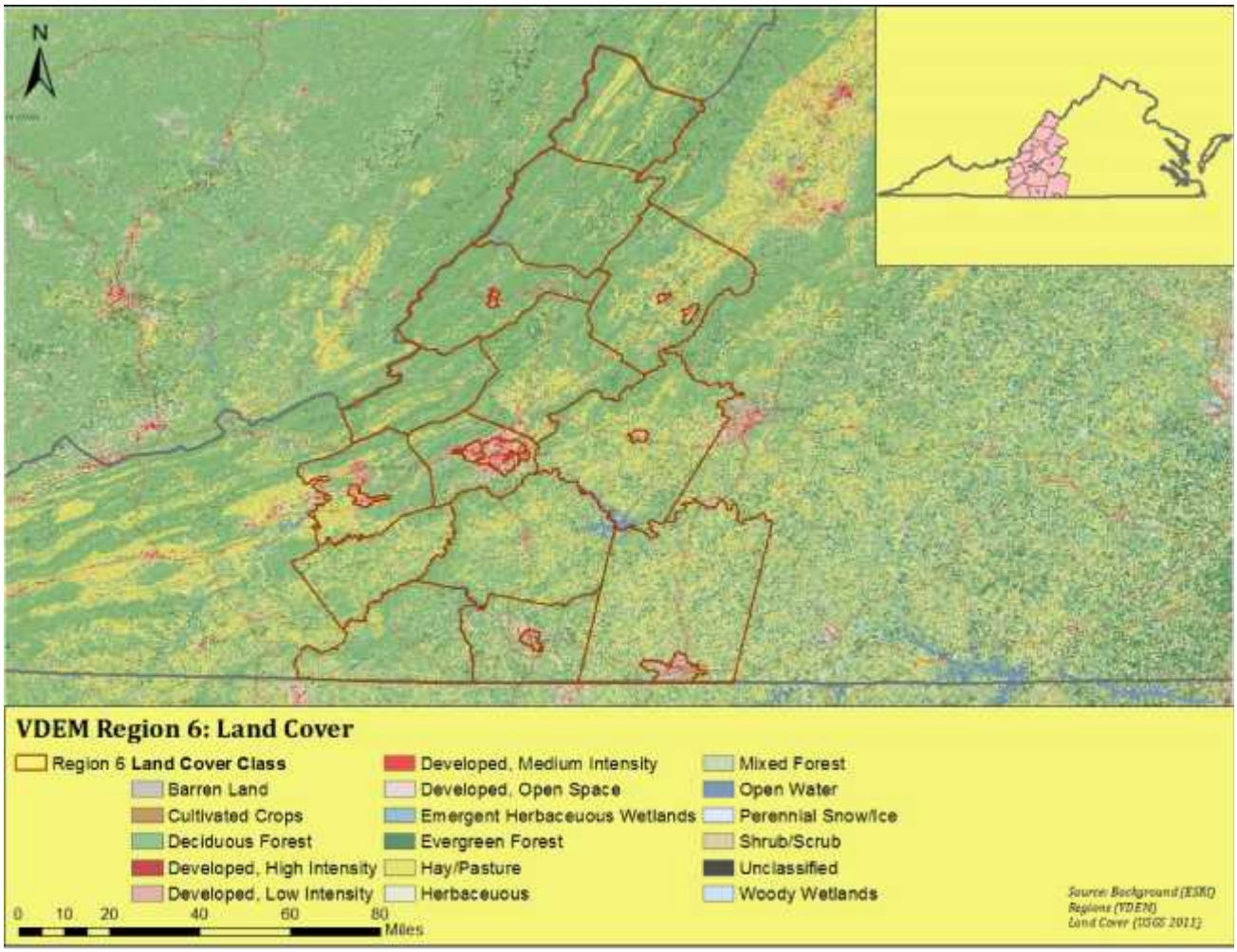
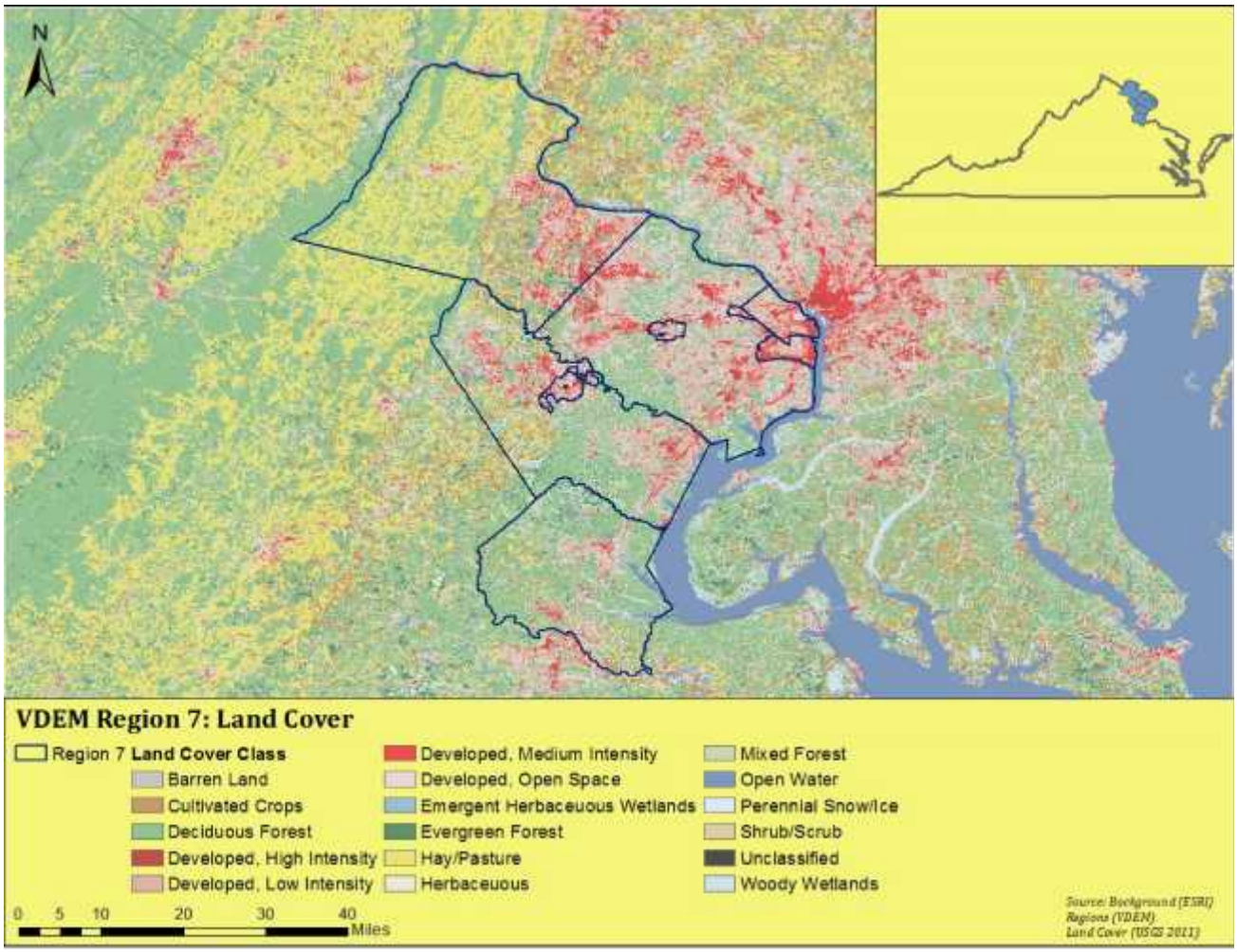


Figure 3.2-23: Land Cover in Virginia – VDEM Region 7



High-Density Land Use & Population

The US Census Bureau defines a high-density area as a census block that contains at least 1,000 residents per square mile. A low-density area contains less than 1,000 residents per square mile[18].

Table 3.2-3 lists the changes in population and high-density land since 2000, as of 2010. This aligns with the long-term urbanization trends in Virginia, such as the increasing suburban development in areas adjacent to Washington D.C., Richmond, Hampton Roads, and the I-95 corridor. The land use development changes observed in this analysis also correspond to the projected population growth noted previously.

Table 3.2-3: Changes in Population and High-Density Land since 2000, by Area[19]

Area	Population Change (2010 Total)	% of Population in High-Density Area	Change in % of Population	Population per Square mile in High-Density Areas	Change in % of High-Density Acreage
Central	+211,560 (1,577,807 people)	66.7%	+2.4%	+22.7 (3,262,2 people)	+0.6%
Eastern	+4,301 (141,676 people)	22.9%	+1.3%	-315.1 (2,060.6 people)	+0.2%
Hampton Roads	+90,192 (1,656,718 people)	88.9%	+2.1%	+40.7 (4.370,3 people)	+1.0%
Northern	+506,387 (2,623,079 people)	88.9%	+2.5%	+307.3 (4,875 people)	+3.6%
Southside	-5,947 (380,886 people)	30.7%	0.2%	-36.5 (2,541.6 people)	0.0%
Southwest	+3,832 (417,024 people)	28.0%	2.5%	-28.0 (2,254.2 people)	+0.1%
Valley	+56,182 (479,535 people)	52.8%	6.3%	+46.6 (3,254.4 people)	+0.3%
West Central	+56,102 (724,299 people)	55.7%	1.0%	+173.6 (2,996.1 people)	+0.1%
Virginia	+922,509 (8,001,024 people)	72.2%	3.3%	+136.2 (3,947.7 people)	+0.5%

Unsurprisingly, the largest concentration of population in high-density areas are found in the Hampton Roads and Northern Virginia areas. These areas have 88.9% and 88.8% (respectively) of residents occupying high-density areas. The eastern and southwest regions had significantly fewer people in high-density areas – 22.9% and 28.0% (respectively). That said, the percentage of residents living in high-density areas increased for all areas of Virginia between the 2000 and 2010 Censuses.[20]

An indicator of how efficiently land is being used examines population rates on land developed for residential, commercial, and industrial uses. Higher rates typically indicate a more compact and efficient settlement pattern, while lower values indicate a more dispersed one. Nationwide, the pattern since the 1980s has been toward fewer people per developed land acre (e.g., more suburban development than urban growth). In 2012 (the last year for which data is available), Virginia had 2.6 residents per developed acre; this is a decrease from 3.0 residents per acre in 1982. The rate is lower than the national average of 2.8 residents per acre, and results in Virginia being ranked 21st in the nation.[21]

Local Plan Land Use and Development

The Commonwealth of Virginia requires that every locality develop a comprehensive plan for 'guiding and accomplishing a coordinated adjusted and harmonious development of the territory' (Code of Virginia §15.2-2223). Localities are required to show long-range recommendations for the development of the area covered by the plan. Comprehensive plans are typically reviewed annually to track progress and set goals for upcoming years.

All local hazard mitigation plans include a general overview of land use and development trends in the region. For this revision of the state plan, each local hazard mitigation plan was reviewed for information on local trends. Table 3.2-4 shows the main data sources and trends as determined by the local plans. Eighty percent (16 out of 20) of the plans refer to the jurisdictions' local comprehensive plan(s). Usually the local comprehensive plans were used as a reference for development trends and general land use information. It is important to combine the comprehensive plan data with hazard mitigation, as future development will influence the degree to which citizens are prone to natural hazards. Future revisions of the local hazard mitigation plans should use the corresponding local comprehensive plan information regarding land use and development. This inclusion by the local plans will make the next revision of the state plan stronger in terms of land use and development patterns in the Commonwealth.

Every local plan used some derivative of Census data as its source of population totals. In addition to the US Census Bureau, some plans referenced figures and projections from the

Virginia Employment Commission, and the Weldon Cooper Center for Public Service at the University of Virginia. In the local hazard mitigation plans, general demographics were discussed in either textual or tabular form. Some plans included population projections or pointed out areas of high population density and intense land use.

Table 3.2-4: Local hazard mitigation plan review of land use & development data

PDC and/or Jurisdiction Name and Number	Summary of Population Trends and/or Land Use Changes	Uses Comp. Plan Data?		Uses Other Data?	
		Y/N	How?	Y/N	What?
Lenowisco PDC*(1)	City of Norton is urban and suburban. Lee, Scott, and Wise counties are rural, but residential development is anticipated to be on the rise.	Yes	Discussion of plans and ordinances (excluding Lee County)	Yes	Building codes, floodplain ordinance, floodplain management plan, planning and zoning ordinances
Cumberland Plateau PDC*(2)	Population has been declining since 1980s.	Yes	Discussion of plans and ordinances	Yes	Natural resource data, top employers
Mount Rogers PDC*(3)	Fifty-eight percent forestland; Mountainous terrain inhibits development except for limited valley areas. Population and population growth is unevenly distributed throughout the region.	No		Yes	Economic overview, top employment sectors, natural resources data
New River Valley PDC*(4)	Large percentage of timberland. Montgomery and Floyd County experiencing rapid population increases, while Giles, Pulaski, and City of Radford have experienced population decline.	Yes	Map of future growth areas	Yes	Weldon Cooper Center, Virginia Employment Commission, top employers, various geological data sources, natural resources data
Roanoke Valley-Allegheny RC*(5)	Mostly rural, except for the Roanoke metropolitan area. Significant portions of mountainous terrain.	Yes	Suggests that local comp plans use the regional hazard mitigation plan, and that hazards are included in comp plans	Yes	Natural resources data, building permits, population data
Central Shenandoah PDC*(6)	Rural with high quality natural resources.	No		Yes	Natural resources data

Table 3.2-4: Local hazard mitigation plan review of land use & development data

PDC and/or Jurisdiction Name and Number	Summary of Population Trends and/or Land Use Changes	Uses Comp. Plan Data?		Uses Other Data?	
		Y/N	How?	Y/N	What?
Northern Shenandoah Valley RC*(7)	Just west of the Washington DC metropolitan area, rapidly developing region. Areas of urban concentration with less concentrated outlying areas as well	Yes	Population projections and development plans, land use	Yes	Population data, natural resources data
Northern Virginia RC (8)	Very urbanized location around nation's capital. Sprawl continues throughout area. Population expected to continue increasing at record levels.	Yes	Zoning	Yes	Metropolitan Washington Council of Governments, Cooperative Forecast for Population and Job Growth, Virginia Economic Development Partnership, National Land Cover Dataset, Top employers
Rappahannock-Rapidan RC*(9)	Mostly rural but significant increases in population and development focused in the areas that are closer to Northern Virginia and Washington DC.	Yes	Land use	Yes	Land cover, UVA Geostat Center, US Census of Agriculture, major transportation routes, Virginia Employment Commission
Thomas Jefferson PDC*(10)	Majority of land is field or forest. All counties in the region experienced population growth from 2000 to 2010. Residential is the primary change of use for most land in the region.	Yes	Current population density, land use and development trends	Yes	Virginia Employment Commission, labor market statistics, Charlottesville Area Association of Realtors and American Community Survey for housing data
Region 2000*(11)	Mostly forest and fields. Businesses centered in a few residential areas.	Yes	Table relates to hazard mitigation	Yes	Population data, land use discussion

Table 3.2-4: Local hazard mitigation plan review of land use & development data

PDC and/or Jurisdiction Name and Number	Summary of Population Trends and/or Land Use Changes	Uses Comp. Plan Data?		Uses Other Data?	
		Y/N	How?	Y/N	What?
West Piedmont PDC (12)	Mix of urban/suburban and rural land uses. Increase in recreational and business development.	Yes	Land use maps in the appendix. Description of land use and development trends by jurisdiction.	Yes	Map of physiographic provinces, income and housing characteristics, top employers
Southside PDC*(13)	Significant percentage of the region is forested land. Predominant topographic feature is rolling hills. No population data	No		Yes	General population data
Commonwealth Regional* (14)	Majority of land is forested or agricultural. Low intensity residential constitutes less than 0.5% of total land cover in most jurisdictions.	Yes	Land Use	Yes	National Land Cover Dataset, UVA Geostat Center, Weldon Cooper Center, Virginia Employment Commission, housing characteristics, top employers, general economic trends
George Washington RC (16)	Rapid population growth due to proximity to Washington D.C.	Yes	Land use, transportation resources, environmental concerns, development targets	Yes	Employment estimates and projections from EMSI Complete Employment
Northern Neck PDC*(17)	Development trends towards large residential subdivisions, mainly waterfront property. Steep slopes limit inland development	No	Textual description of current and future land uses, but no quantitative data	Yes	Weldon Cooper Center, Virginia Employment Commission Community Profiles

Table 3.2-4: Local hazard mitigation plan review of land use & development data

PDC and/or Jurisdiction Name and Number	Summary of Population Trends and/or Land Use Changes	Uses Comp. Plan Data?		Uses Other Data?	
		Y/N	How?	Y/N	What?
Middle Peninsula PDC (18)	Woodland to residential conversion, increase in waterfront communities. Mostly rural, but within proximity to metropolitan areas	Yes	Population projections and development trends by jurisdiction.	Yes	Weldon Cooper Center for Public Service for population data
Crater (19) and Richmond Regional (15)*PDCs	Variation of urban and rural. Most of the counties are rural, but the region includes Henrico County (suburban) and the City of Richmond. Varied population growth throughout region.	Yes	Individual description of each jurisdiction's land use and development trends	Yes	Income and housing characteristics, Top employers, Virginia Economic Development Partnership
Accomack-Northampton PDC*(22)	The plan addresses the problem of coastal erosion and flooding. The seafood, poultry, and tourism industry are important to the region.	Yes	Reference to each jurisdiction's comp plan. General description of land uses and development trends.	Yes	Top employers
Southside Hampton Roads* (23)	Most growth occurring in cities (VA Beach, Suffolk). Norfolk is the most densely developed. Portsmouth is adjacent to the shipyard. Numerous military installations (naval bases and naval air stations)	Yes	Population and demographic characteristics. Very general discussion of development trends	Yes	Virginia Economic Development Partnership, Bureau of Labor Statistics, U.S. Geological Survey, NLCD

*indicates plans that have not been updated since the 2013 state hazard mitigation plan update; some are in the process of being updated.

Comparison of Statewide Land Use and Local Plan Land Use

Population growth and development trends are important factors when considering the risk or the damage posed by a natural disaster. Development in hazard-prone areas should be undertaken with full knowledge of potential threats.

Overall, the land use information compiled for this plan and in the local plans show similar trends. Northern Virginia continues to experience a surge in population and development, while South-Central and Southwest Virginia experience relatively low development, and in some extreme cases, population decline.

Endnotes

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Section 3.3: Declared Disasters & NCEI Data

Disaster Declarations Background

Local and state governments share responsibility for public health and safety and for helping residents recover after a disaster strikes. In some cases, a disaster is beyond the capabilities of the state and local governments to respond. In 1988, the *Robert T. Stafford Disaster Relief and Emergency Assistance Act* was enacted to support state and local governments and their citizens when disasters overwhelm them and exhaust their resources. This law, as amended, establishes a process for requesting and obtaining a federal disaster declaration, defines the type and scope of assistance available from the federal government, and sets the conditions for obtaining that assistance[1].

A federal disaster declaration could result from a hurricane, earthquake, flood, tornado, major fire, or other event which the President determines warrants supplemental federal aid. The event must be more than the state or local governments can handle alone. If declared, funding comes from the President's Disaster Relief Fund, which is managed by FEMA, and disaster aid programs of other participating federal agencies. Federal disaster declarations typically follow these steps:

- Local governments are the first to respond, supplemented by neighboring communities through mutual aid agreements and volunteer agencies. If overwhelmed, local governments turn to the state for assistance;
- The state responds with state resources, such as the Virginia Emergency Support Team, National Guard, and other state agencies;
- A Rapid Needs Assessment (RNA) which focuses on lifesaving needs, imminent hazards, and critical lifelines is performed, usually within the first 24 hours of an event;
- An Initial Damage Assessment (IDA) is performed by the local government, which evaluates damages to residences, businesses, and public infrastructure (i.e., roads, bridges, public utilities, etc.
- IDAs determine if there is sufficient damage to warrant a Joint Preliminary Damage Assessment (PDA) which consists of local, state, and federal staff verifying the IDAs to determine if enough damage exists to warrant federal recovery assistance;
- A Major Disaster Declaration is requested from the Governor to the FEMA Region III Administrator, who evaluates the request and provides recommendations to the President based on the RNA and PDAs and the type of federal assistance requested;
- A request for hazard mitigation assistance usually accompanies the disaster declaration request;

- Depending on the nature of the disaster and the type of assistance being requested, a Presidential Declaration could be approved within a couple of hours to a couple of weeks;
- A Presidential Declaration can also be approved prior to an event (i.e. hurricane) if it anticipated that the damage will be severe, to pre-position resources;
- Federal funds for mitigation post-disaster are based on 15% of the Stafford Act disaster recovery assistance that is provided to the jurisdictions statewide.

Federal Disaster Declarations in Virginia

Since the HIRA was developed for the 2013 plan, there have been two federal disaster declarations in Virginia. An important source for identifying hazards that can affect the Commonwealth is the record of federal disaster declarations. Per FEMA, there have been 49 major disaster declarations, eight emergency declarations, and seven fire management assistance declarations for Virginia dating back to 1957. Table 3.3-1 shows the federal emergency and disaster declarations in Virginia from 1957 through 2016.

Tropical systems, flooding, and winter weather tend to have greater impacts and result in the most declarations in the Commonwealth; in 1996 and 2003 one of each of these hazards was declared in the commonwealth. Table 3.3-1 shows the number of declared disasters, and jurisdiction, for Virginia. Fifteen jurisdictions have had 10 or more disasters during the period 1969 to 2016.

Table 3.3-1: FEMA Disaster Declarations in Virginia since 1957

Disaster Number	Date of Declaration	Hazard Type/Name	Jurisdictions Declared
68	February 1957	Flood	NA
123	March 1962	Severe Storms, High Tides, Flooding	NA
149	March 1963	Flood	NA
274	August 1969	Severe Storms & Flooding (Hurricane Camille)	27
339	June 1972	Tropical Storm Agnes	106
358	October 1972	Severe Storms & Flooding	3
359	October 1972	Severe Storms & Flooding	31
3018*	October 1976	Drought	38
525	January 1977	Ice Conditions	39
530	April 1977	Severe Storms & Flooding	16
3046*	July 1977	Drought	62
543	November 1977	Severe Storms & Flooding	8
593	July 1979	Storms & Flash Flooding	1
606	September 1979	Severe Storms & Flooding	1

Disaster Number	Date of Declaration	Hazard Type/Name	Jurisdictions Declared
707	May 1984	Severe Storms & Flooding	3
755	November 1985	Severe Storms & Flooding	52
847	November 1989	Severe Storms, Mudslides, & Flooding	1
944	May 1992	Severe Storms & Flooding	28
3112*	March 1993	Severe Winter Storm	136
1007	December 1993	Severe Storms & Tornadoes	1
1014	March 1994	Severe Ice Storms, Flooding	72
1021	April 1994	Severe Winter Ice Storm	33
1059	July 1995	Severe Storms & Flooding	24
1086	January 1996	Blizzard of 1996 (severe storm)	127
1098	January 1996	Flooding -- Snow Melt	27
1135	September 1996	Hurricane Fran	55
1242	September 1998	Hurricane Bonnie	5
1290	September 1999	Tropical Storm Dennis	1
1293	September 1999	Hurricane Floyd	47
1318	February 2000	Winter Storms	109
1386	July 2001	Southwest VA Floods	10
3168*	September 2001	Terrorist Attack Emergency Declaration	1
1392	September 2001	Pentagon Attack	1
2394**	November 2001	Heard Mountain Fire Complex	2
2393**	November 2001	Shenandoah Gap Fire Complex	1
2390**	November 2001	Far Southwest Fire Complex	3
2397**	February 2002	Fultz Run Fire	1
1406	April 2002	Southwest VA Floods	10
1411	May 2002	Floods/Tornadoes	9
1458	April 2003	NOVA Snowstorm & SW VA Floods	22
1491	September 2003	Hurricane Isabel	100
1502	November 2003	SW Virginia Floods	6
1525	June 2004	Severe, Storms, Tornadoes, and Flooding	4
1544	September 2004	Severe Storms, Flooding And Tornadoes Associated with Tropical Depression Gaston	10
1570	October 2004	Severe Storms and Flooding from the remnants of Hurricane Jeanne	10
3240*	September 2005	Hurricane Katrina Evacuation	1
2637**	April 2006	Bull Mountain Fire	1
1655	July 2006	Severe Storms, Tornadoes, And	10

Disaster Number	Date of Declaration	Hazard Type/Name	Jurisdictions Declared
		Flooding	
1661	September 2006	Tropical Depression Ernesto, Severe Storms and Flooding	22
1862	December 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a November Nor'easter	12
1874	February 2010	Severe December Winter Storm (Heavy snow, rain and high winds)	50
1905	April 2010	Severe February Winter Storms and Snowstorms	38
2860**	February 2011	Smith Fire	1
2861**	February 2011	Coffman Fire	1
3329*	August 2011	Hurricane Irene	30
4024	September 2011	August Hurricane Irene	48
4042	November 2011	August Earthquake	9
4045	November 2011	Remnants of September Tropical Storm Lee	8
4072	July 2012	June and July Severe Storms and Straight-line Winds (Derecho)	69
3359*	October 2012	Hurricane Sandy	134
4092	November 2012	October Hurricane Sandy	28
4262	January 2016	Severe Winter Storm and Snowstorm	30
4291	October 2016	Hurricane Mathew	8

*FEMA Emergency Declarations
**FEMA Fire Management Assistance Declarations

Following is a summary description of selected declared disasters.

- **Ash Wednesday Storm in 1962.** Damage was experienced throughout Virginia's Tidewater region. Houses along the coast and bay region were damaged and flooded by high waves and seven to nine-foot water rises. Virginia Beach's concrete boardwalk and sea wall were damaged, and extensive shoreline erosion occurred. The City of Hampton had an estimated $4 million in wind and flood damages. Two feet of snow fell from Charlottesville (21 inches), to Luray (24 inches), to Winchester (22 inches) setting new records.
- **Hurricane Camille in 1969**. This major storm made landfall out of the gulf as a Category 5 Hurricane and weakened to a tropical depression before reaching Virginia. It rained more than 27 inches of rain in Nelson County and over 10 inches in the area from Lynchburg to Charlottesville. Flooding and landslides, triggered by saturated soils, resulted in catastrophic

damage. More than 150 people died, another 100 were injured, and 113 bridges were washed out. At the time, damage was estimated at more than $113 million.

- **Tropical Storm Agnes in 1972.** This event produced devastating flooding throughout the Mid-Atlantic States. Some areas of eastern Virginia received more than 15 inches of rainfall as the storm moved through. The Potomac and James Rivers experienced major flooding, which created five to either foot flood waters in many locations along the rivers. Richmond was impacted the most by these high-water levels. Water supply and sewage treatment plants were inundated, as were electric and gas plants. Four of the five bridges that cross the James River were impassable, while the downtown area was closed for several days, businesses and industries in the area suffered immense damage. Sixteen people lost their lives in the state and damage was estimated at $222 million. In all, 63 counties and 23 cities qualified for disaster relief.
- **Tornado in 1973.** This F3 tornado noteworthy because it touched down in heavily populated areas of Northern Virginia and caused $25 million in damages. The tornado touched down in Prince William County and traveled through the cities of Fairfax and Falls Church before dissipating. Fairfax was hit hardest by this tornado; within a 6-mile damage path, a high school, two shopping centers, an apartment complex, and 226 homes were damaged or destroyed. 37 people were injured.
- **Super Tornado Outbreak in 1974.** This was the worst tornado outbreak in US history, generating the most tornadoes in a 24-hour period. Several states were struck with 148 observed tornadoes, killing 315 people and injuring thousands more. Eight of these tornadoes occurred in Virginia. Wind damage was reported in counties from Russell northward to Loudoun. Hundreds of homes, barns, and mobile homes were damaged or destroyed.
- **The Blizzard of 1983.** An unusually large area of the state was covered with more than 12 inches of snow, setting new records in many places. Richmond received 18 inches, while portions of northern Virginia had almost 30 inches. Strong winds that gusted over 25 mph created high snowdrifts and made clearing of roads a tough task. This storm cost the state more than $9 million in snow removal.
- **Severe Weather Outbreak in 1984.** Severe weather pushed through the state on May 8, spawning tornadoes and producing significant downburst wind damage in central and eastern Virginia. A strong F3 tornado occurred in Hopewell and tracked into Charles City County as an F2. There was extensive home, mobile home, building, and tree damage from these cluster thunderstorms, imbedded tornadoes and windstorms; total damage costs exceeded $50 million.
- **Election Day Flood in 1985.** Heavy rainfall from October 31 through November 6, 1985, caused record-breaking floods over a large region, including western and northern Virginia. Most of the rain fell on November 4 and 5 causing flash flooding. Heavy rainfall was indirectly related to Hurricane Juan. The Roanoke River rose seven feet in one hour and 18

feet in six hours, cresting at 23 feet on November 5. There were 22 deaths in Virginia because of the flooding. FEMA declared 50 jurisdictions disaster areas. Approximately 1.7 million people were affected by the flooding; damages were estimated at $800 million.

- **The Storm of the Century in 1993.** Affecting nearly the entire East Coast, this storm killed 200 people and generated several billion dollars in damage and snow removal. Although its effects in Virginia did not exceed the Ash Wednesday Storm in 1962, it affected more communities ranging from the Chesapeake Bay through central Virginia reaching into Southwest Virginia. Blizzard conditions in western Virginia dropped two to three feet of snow and produced snowdrifts up to 12 feet deep. Snow removal and clean-up costs were estimated at $16 million for the state.
- **The Petersburg/Colonial Heights Tornado in 1993.** This tornado outbreak killed four people and injured 238. The strongest tornado touched down in Petersburg as an F4, with maximum winds estimated at 210 mph. The tornado jumped I-95 and smashed into a Wal-Mart causing the ceiling to collapse, three people died. Major damage occurred in the Old Towne section of Petersburg, destroying several stores and businesses in Colonial Heights. Other tornadoes hit the same day in the Cities of Newport News and Chesapeake. In four hours, 18 tornadoes carved paths through southeast Virginia, setting a Commonwealth record. Total damages were estimated at $52.5 million, making it one of Virginia's most costly tornado outbreaks to date.
- **Ice Storm of 1994.** This winter storm coated portions of Virginia with one to three inches of ice, freezing rain, and sleet. This led to the loss of approximately 10 to 20 percent of trees in some counties, which blocked roads and caused many people to be without power for a week. There were numerous automobile accidents and injuries from people falling on ice. Damages were estimated at $61 million.
- **The Blizzard and Flooding of Winter 1996.** Also known as the 'Great Furlough Storm' due to Congressional impasse over the federal budget, the blizzard paralyzed the Interstate 95 corridor, and reached westward into the Appalachians where snow depths of more than 48 inches were recorded. Several local governments and schools were closed for more than a week. The blizzard was followed with another storm, which blanketed the entire state with at least one foot of snow. To compound matters, heavy snowfall piled on top of this storm's accumulations in the next week, which kept snow pack on the ground for an extended period. This snow was eventually thawed by higher temperatures and heavy rain that fell after this thaw resulted in severe flooding. Total damage between the blizzard and subsequent flooding exceeded $30 million.
- **Hurricane Fran in 1996.** This September 6 hurricane is notable not only for the $350 million in damages, but because of its widespread effects, including a record number of people without power and closure of 78 primary and 853 secondary roads. Rainfall amounts between eight and 20 inches fell over the mountains and Shenandoah Valley, leading to record-level flooding in many locations within this region. 100 people had to be rescued

from the floodwaters and hundreds of homes and buildings were damaged by the floodwaters and high winds.

- **The Christmas Ice Storm in 1998.** This prolonged ice storm struck central and southeast Virginia in the days leading up to Christmas. Ice accumulations exceeded an inch, bringing down many trees and power lines within this region. 400,000 people were without power on Christmas Eve, and some of these people did not get their power back for up to ten days. Property damage from this storm was estimated to be around $20 million.
- **Wildfires of 1999.** The Purgatory Mountain Fire in Botetourt County, one of the largest fires of the year, burned 1,285 acres and cost more than $166,000 to contain. A fire on Clinch Mountain in Southwest Virginia burned only 240 acres but containment costs exceeded $97,000 due to the mountainous terrain and extreme drought conditions. A total of 1,749 fires burned 12,118 acres, considerably exceeding the five-year annual average of 1,320 fires and 6,081 acres.
- **Hurricane Floyd in 1999.** This large hurricane brought 10 to 20 inches of total rainfall over portions of southeast Virginia, with wind gusts up to 100 mph and storm surges approaching seven feet. These three elements combined caused storm damages of approximately $255 million. This disaster will long be remembered in the City of Franklin and Southampton and Isle of Wight Counties, as well as the other 44 Virginia jurisdictions included in the major disaster declaration. More than 8,900 homes, businesses and public facilities were either destroyed, significantly damaged, or sustained moderate impacts. In addition to direct property damage, lost business revenues were estimated at $13.1 million, with the City of Franklin losing nearly $2 million in tax revenues. Direct crop losses were estimated at $17 million.
- **Terrorist Attack in 2001.** American Airlines Flight 77 was hijacked and flown into the Pentagon in Arlington County. The hijacking resulted in 150 fatalities when it crashed into the west side of the building. Combined with the attack on the World Trade Center and the impacts of the plane crash in Pennsylvania, this event changed terrorism policy in the US and led to the creation of the Department of Homeland Security, where FEMA is now administered.
- **Southwest Virginia Flooding, 2001-2004.** A total of six federal disasters, primarily flooding and severe storms, were declared in Southwest Virginia from 2001-2004 (Disasters 1386, 1406, 1411, 1458, 1502, 1525 and 1570). The worse hit counties were Tazewell (all 6 disasters), Buchanan (5 disasters), and Russell (4 disasters). Dickenson, Lee, Smyth, and Wise Counties were also declared in half of these disasters. Many of these disasters have storm tracks along the mountain valleys, producing excessive localized flooding. Catastrophic flooding has been experienced in rural settlements as well as in Bluefield, Hurley, Appalachia, Pennington Gap, Norton, Dante and Wise.
- **Hurricane Isabel in 2003.** Hurricane Isabel entered Virginia September 18 after making landfall along the North Carolina Outer Banks. The Commonwealth sustained tropical storm

winds for 29 hours with some maximum winds approaching 100 mph. The hurricane produced storm surge of five to eight feet along the coast and in the Chesapeake Bay with rainfall totals between two and 11 inches along its track. Rainfall of 21 inches was measured near Waynesboro Virginia. Damages due to wind, rain, and storm surge resulted in flooding, electrical outages, debris, transportation interruptions, and damaged homes and businesses. At the height of the incident, approximately 6,000 residents were housed in 134 shelters and curfews were imposed in many jurisdictions. Further damages occurred when a series of thunderstorms and tornados came through many of the designated areas in the southeast portion of Virginia on September 23. There were a total of 36 confirmed fatalities. More than 93,000 individuals, families and businesses registered for federal assistance. Residential impacts included 1,186 homes reported destroyed and 9,110 with major damage, 107,908 minor damage; losses estimated to exceed $590 million. Of the 1,470 businesses involved, 77 were reported destroyed, 333 suffered major damage and 1,060 businesses suffered minor or casual damage, with losses exceeding $84 million. Public assistance exceeded $250 million and continues to increase. More than two-thirds of households and businesses within the Commonwealth were without power. Remote locations did not have power restored for three weeks.

- **Tropical Depression Gaston in 2004.** Downgraded from a hurricane, Tropical Depression Gaston moved into Virginia from the south during the morning of Monday, August 30, 2004. Although forecasts called for accumulations of one to three inches in Central Virginia, the system stalled over the Richmond metropolitan area and brought as much as 14 inches of rain. In the cities of Richmond, Hopewell, Colonial Heights, and Petersburg and the counties of Charles City, Chesterfield, Dinwiddie, Henrico, Hanover, New Kent, Prince George, and King William homes, apartments, and businesses in low-lying areas were flooded and many streets were impassable due to severe damage, including I-95, I-64, and I-195. The Office of the Chief Medical Examiner confirmed nine deaths directly linked to Tropical Depression Gaston.
- **Tropical Depression Ernesto in 2006.** Downgraded from a hurricane, tropical depression Ernesto moved into Virginia on September 1. The system slowed over coastal and eastern Virginia, causing rainfall accumulations of up to 10 inches of rain in the cities of Hampton, Poquoson and Newport News. Serious flooding and shoreline damage occurred in Northern Neck with damages most significant in Northumberland, Lancaster and Westmoreland Counties. A public assistance disaster declaration provided aid to the Commonwealth and 25 local governments.
- **November Nor'easter and Tropical Depression Ida in 2009.** A combination of a Nor'easter and the remnants of Tropical Depression Ida led to significant rainfall which caused flooding and damage amounting to approximately $388 million, $25 million of which was in Norfolk alone. The areas affected were Hampton, Newport News, Norfolk, Virginia Beach, Chesapeake, Poquoson, Portsmouth, James, and York[2].

- **Severe December Winter Storm in 2009.** A nor'easter that formed over the Gulf of Mexico developed into a winter storm affecting much of the East Coast. The highest single day snowfall associated with this storm was 27 inches reported at the weather station in Buchanan Virginia.
- **Severe February Winter Storm in 2010.** A nor'easter developed into a winter storm that produced significant snowfall affecting northern Virginia. The highest single day snowfall associated with this storm was 34 inches reported at the weather station near Purcellville in Loudoun County.
- **Hurricane Irene in 2011.** Initially, Hurricane Irene was announced as an emergency declaration. After the Hurricane hit and damaged was assessed, this hurricane was declared a major disaster, resulting in federal funding. Hurricane Irene was a large tropical cyclone affecting the Caribbean and East Coast of the US. The Commonwealth experienced the second highest number of power outages ever with 2.5 million citizens without power after the storm. Irene is ranked as the seventh costliest hurricane in US history, costing approximately $15.8 billion[3].
- **Mineral Earthquake in 2011.** On August 23, 2011, a 5.8 magnitude earthquake occurred approximately seven miles from Mineral, Virginia close to Louisa County. Hundreds of aftershocks were felt for several days. Some of these aftershocks were recorded at a 4.5 magnitude[4]. Louisa County received over $6.6 million in individual assistance as well as $1.6 million in low-interest loans to individuals and businesses through the Small Business Administration[5].
- **Tropical Storm Lee in 2011.** Tropical Storm Lee caused heavy rain and flooding in Virginia on September 8 and 9. Caroline, Essex, Fairfax, King and Queen, King George, Prince William, and Westmoreland Counties, and the City of Alexandria were approved for federal disaster assistance. The heavy rain caused significant damage to neighborhoods and businesses in Fairfax and Prince William Counties. Approximately 500 individuals were displaced from their homes in Prince William County[6].
- **Derecho in 2012.** Severe thunderstorms and straight-line winds exceeding 80 mph impacted Virginia on the evening of June 29 and the morning hours of July 1. Fifteen storm-related deaths were reported[7]. A large portion of the Commonwealth lost power for several days, during a significant heat wave.
- **Hurricane Sandy in 2012.** Hurricane Sandy was declared a major disaster in Virginia on November 26, 2012, after damage assessment surveys were conducted. The declaration included Individual Assistance for Accomack County, Public Assistance for 25 counties and three independent cities, and Hazard Mitigation Assistance for all jurisdictions in the commonwealth. Damage assessments found that approximately 245 residential structures were affected, and that the primary impact was damage to utilities. $10.5 million was obligated under the Public Assistance Program for affected jurisdictions[8].

- **Severe Winter Storm and Snowstorm in 2016.** The commonwealth was impacted by a severe winter storm on January 22 and 23, 2016, resulting a Presidential Disaster Declaration. The declaration authorized reimbursement for emergency protective measures for 25 jurisdictions, resulting in more than $47 million obligated to impacted jurisdictions[9].
- **Hurricane Matthew in 2016.** Hurricane Matthew impacted a large swath of the eastern seaboard in 2016, including the commonwealth. The Governor requested and received Individual Assistance for seven cities and two counties, and Hazard Mitigation Assistance for the entire commonwealth; the declaration was later amended to include Public Assistance. The Preliminary Damage Assessment found that 2,306 residential structures were impacted by Matthew. More than $10 million in Individual Assistance funding was obligated, along with $6.1 million in Public Assistance funding[10].

Federal Disaster Data Compilation

Federally Declared Disaster data from previous hazard mitigation plans was used as the starting point to update the records. Once the data from the new sources was compiled and all available missing data was filled in using FEMA's Declared Disasters webpage, the data was ready to be processed into HIRA categories. Descriptions of the disasters can vary quite dramatically; thus, they needed to be grouped into broad hazard type categories for comparison. Table 3.3-2 shows how the declared disaster categories were grouped into the HIRA hazard categories for this plan update.

Table 3.3-2: FEMA disasters declarations to align with the HIRA hazards

HIRA Category	General Categories Included
Drought	Drought
Flood	Flood Flood / Tornado Hurricane Thunderstorm / Flood Thunderstorm / Flood / Landslide Winter Storm / Flood
High Wind	Hurricane Thunderstorm / Flood Thunderstorm / Flood / Landslide Thunderstorm / Tornado / Flood Thunderstorm / Tornado Tropical Storm
Tornado	Flood / Tornado Thunderstorm / Tornado / Flood Thunderstorm / Tornado

HIRA Category	General Categories Included
Winter Storm	Winter Storm Winter Storm / Flood
Wildfire	Wildfire
Landslide	Thunderstorm / Flood / Landslide
Dam	NA

Since many of these disaster declarations have multiple events and cover large geographic areas, there is the possibility that a municipality has received funding for a disaster that did not occur in that particular municipality. For example, an event that included severe storms, flooding, and tornados, could have only had a tornado in one county, while the disaster assistance was provided to multiple counties. Without going through each disaster individually, there is no simple method to separate these events. Even if each record is searched individually, early disaster records have significantly less information and detail than modern day records.

To be able to visualize the number of different disaster types that have impacted Virginia the maps showing the individual federally declared disasters have been double counted when different hazards have occurred during a single event. For example, the storm in July 2006 (DR-1655) was classified by FEMA as Severe Storms, Tornado, and Flooding. To be able to show these as separate events each designated county was given a score of one for each of the event types for this one declare disaster. Each declared disaster is represented from the assigned FEMA categories. This may result in some types of categories not being represented to its fullest account. One exception to this is the landslide events that resulted from Hurricane Camille in 1969 (DR-274) and the Severe Storm and Flooding in 1995 (DR-1059) that impacted Nelson and Madison counties, respectively.

The total number of declared disasters (Figure 3.3-1) does not double count these events. If one was to sum up the total number of individual hazard events each county was given and compared it to the total number of declared disasters they would not be equal, for reason discussed above. In addition, for communities declared for disasters, contiguous communities can also be added.
Figures 3.3-2 through 3.3-9 show the number of declared disasters, by jurisdiction, for the individual hazard HIRA categories. Flood, high wind, and winter weather represent the majority of Presidential Disaster Declarations in Virginia. Landslide, land subsidence, communicable disease, solar storms, and flooding due to impoundment failure are hazards that have been considered in this plan, but do not have any federally declared disasters directly associated with them.

The following jurisdictions have experienced 14 or more declared disasters from 1957 through December 2016:

- Alexandria, City of
- Alleghany County
- Amherst County
- Augusta County
- Bath County
- Bedford County
- Buchanan County
- Greene County
- King George County
- Nelson County
- Rockbridge County

Figure 3.3-1: Total Federal Disaster Declarations

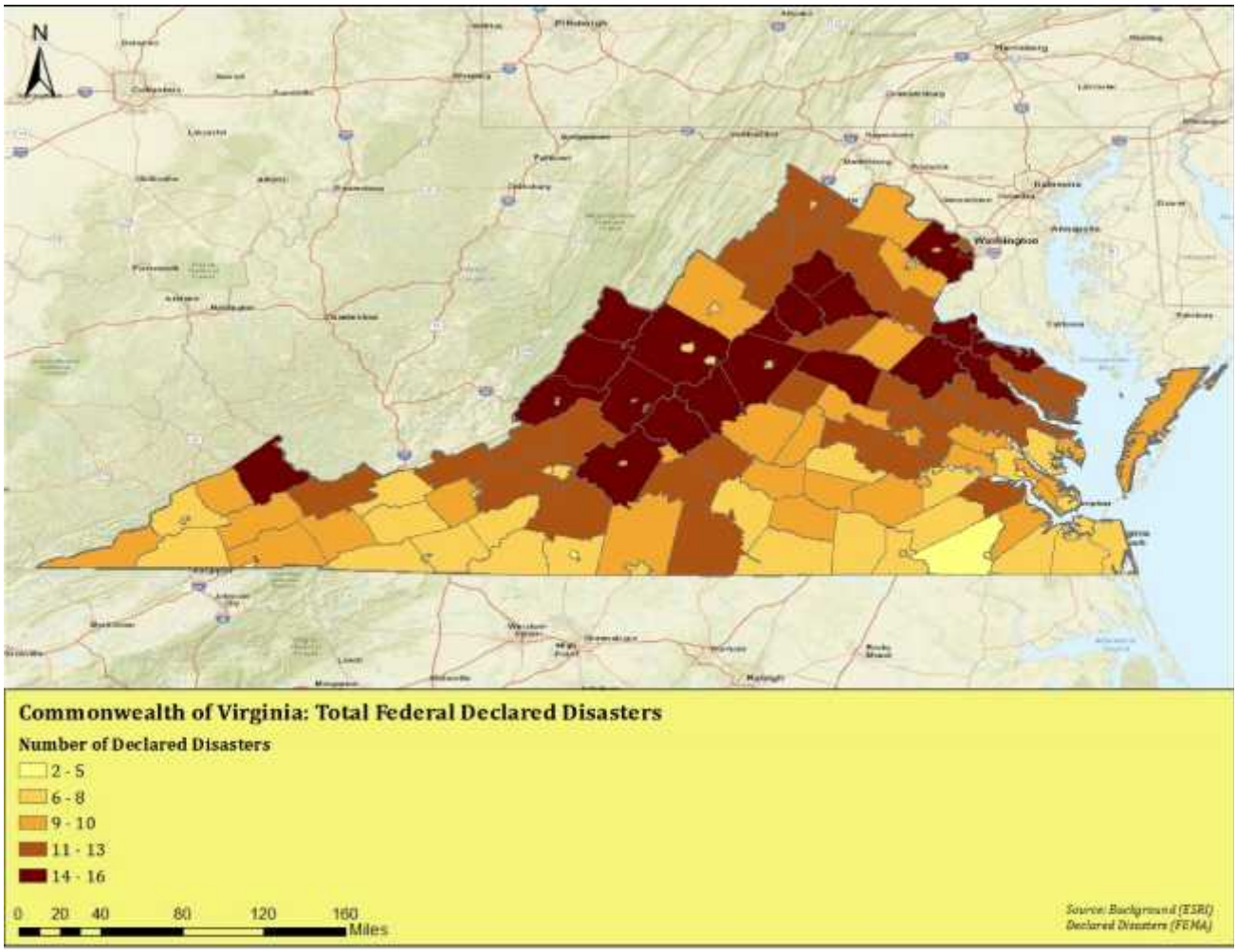


Figure 3.3-2: Drought Federal Disaster Declarations

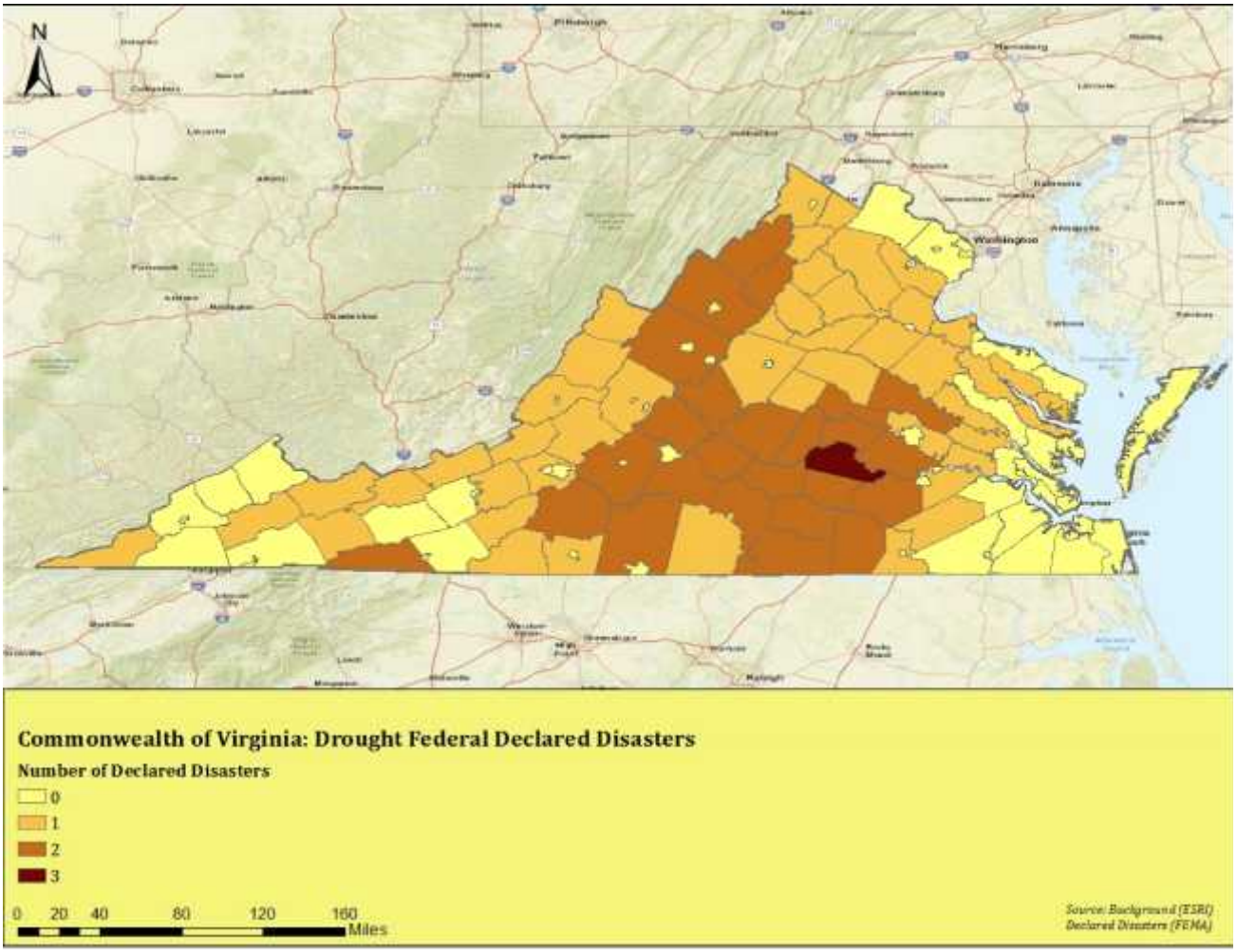


Figure 3.3-3: Flood Federal Disaster Declarations

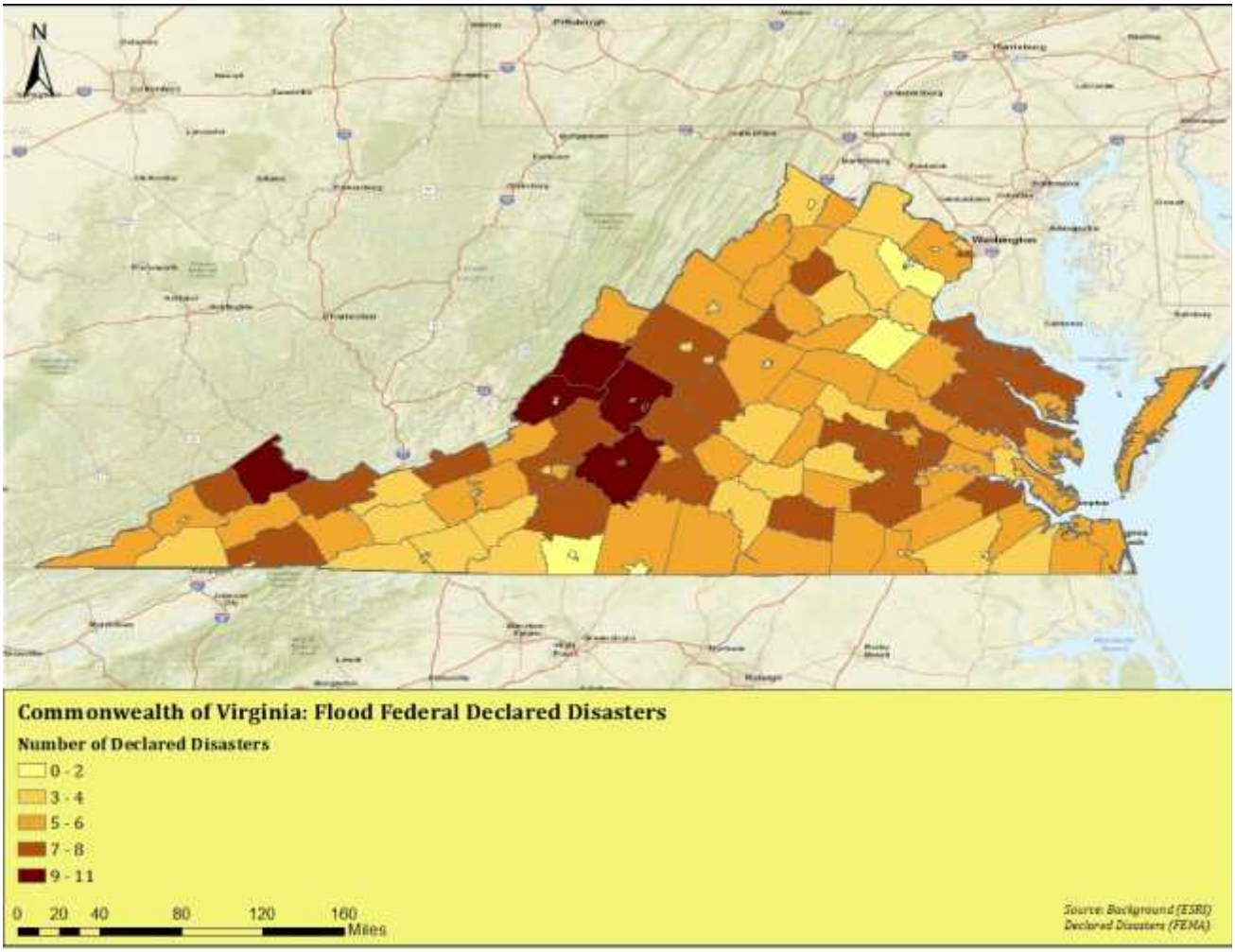


Figure 3.3-4: Non-Rotational Wind Federal Disaster Declarations

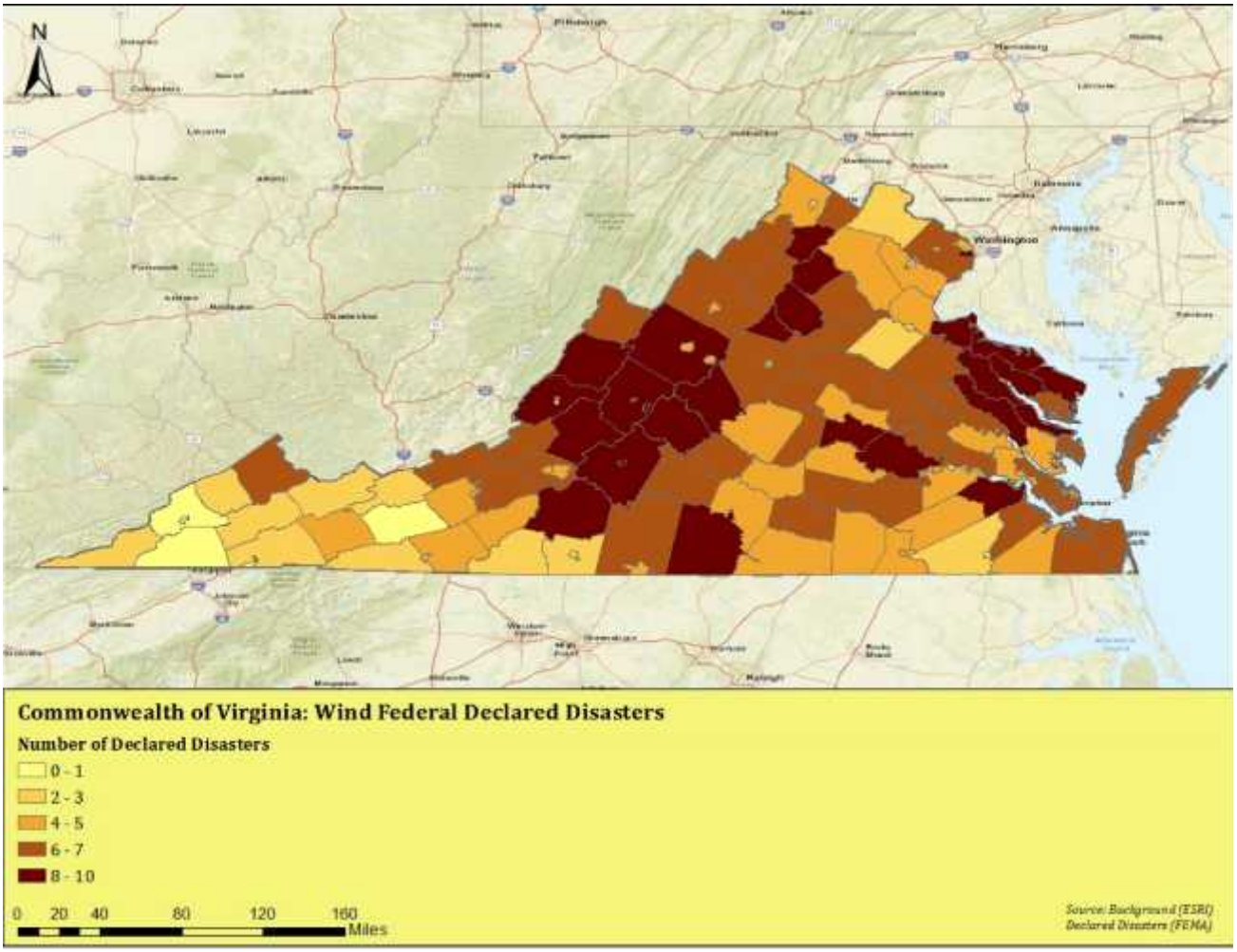


Figure 3.3-5: Tornado Federal Disaster Declarations

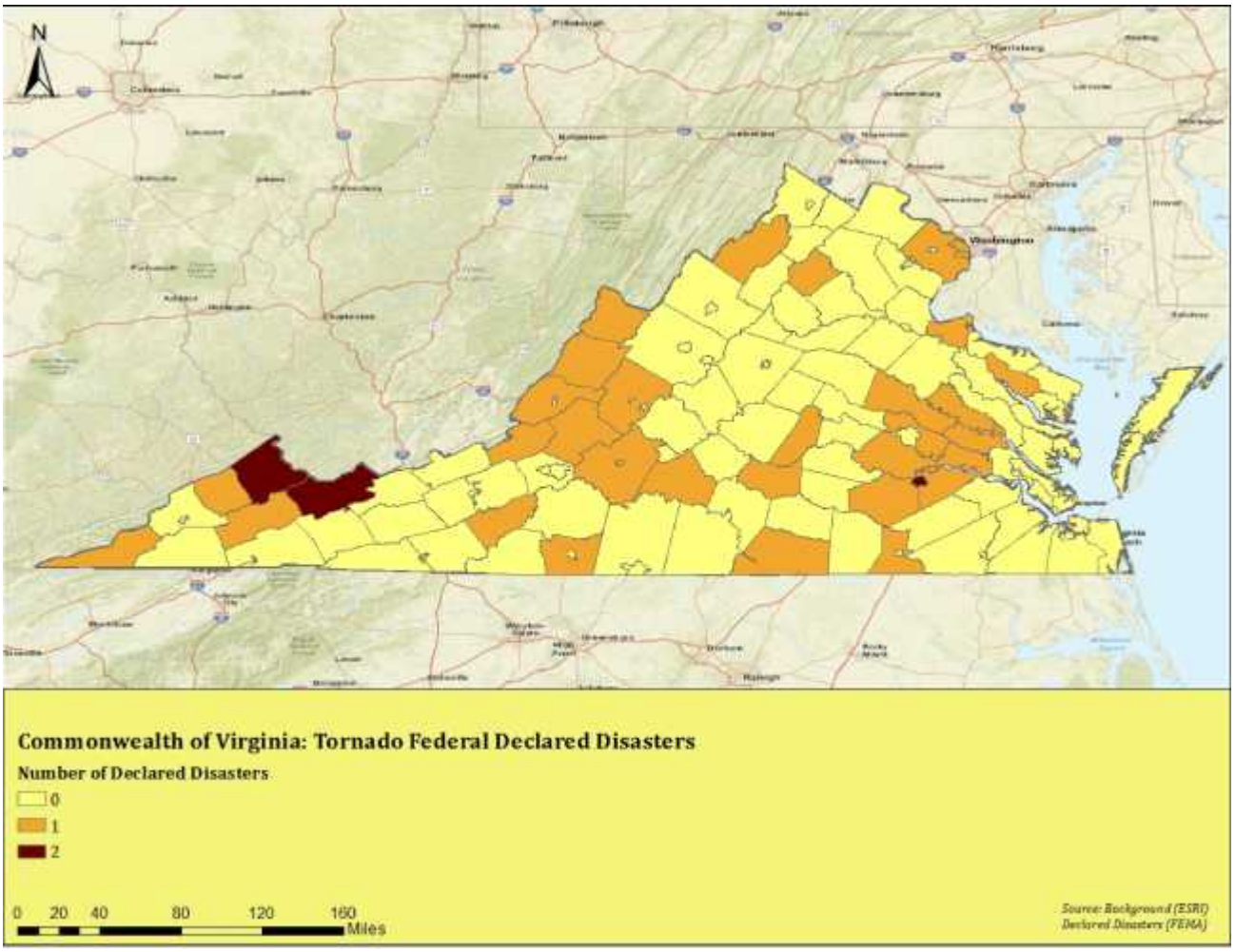


Figure 3.3-6: Winter Storm Federal Disaster Declarations

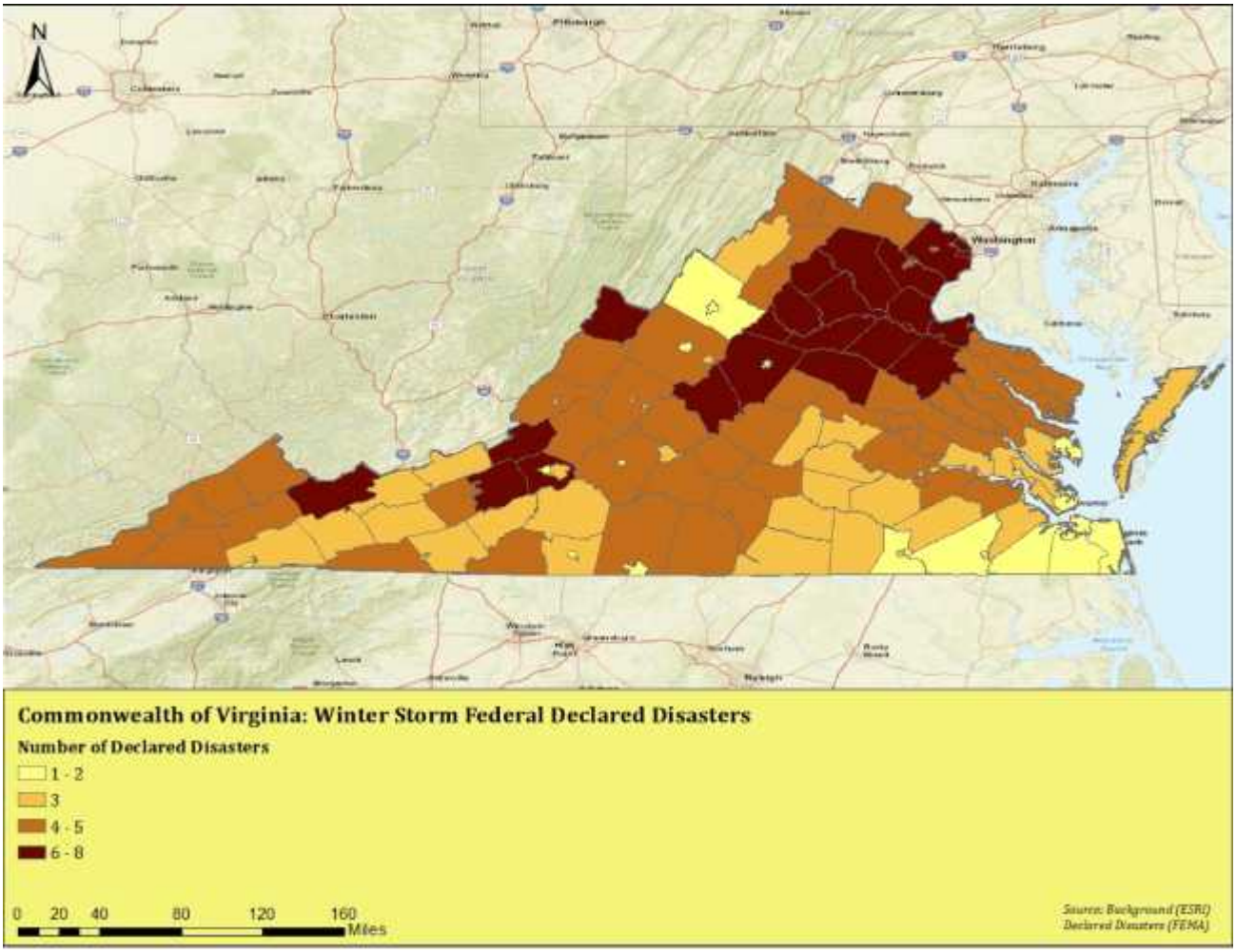


Figure 3.3-7: Wildfire Federal Disaster Declarations

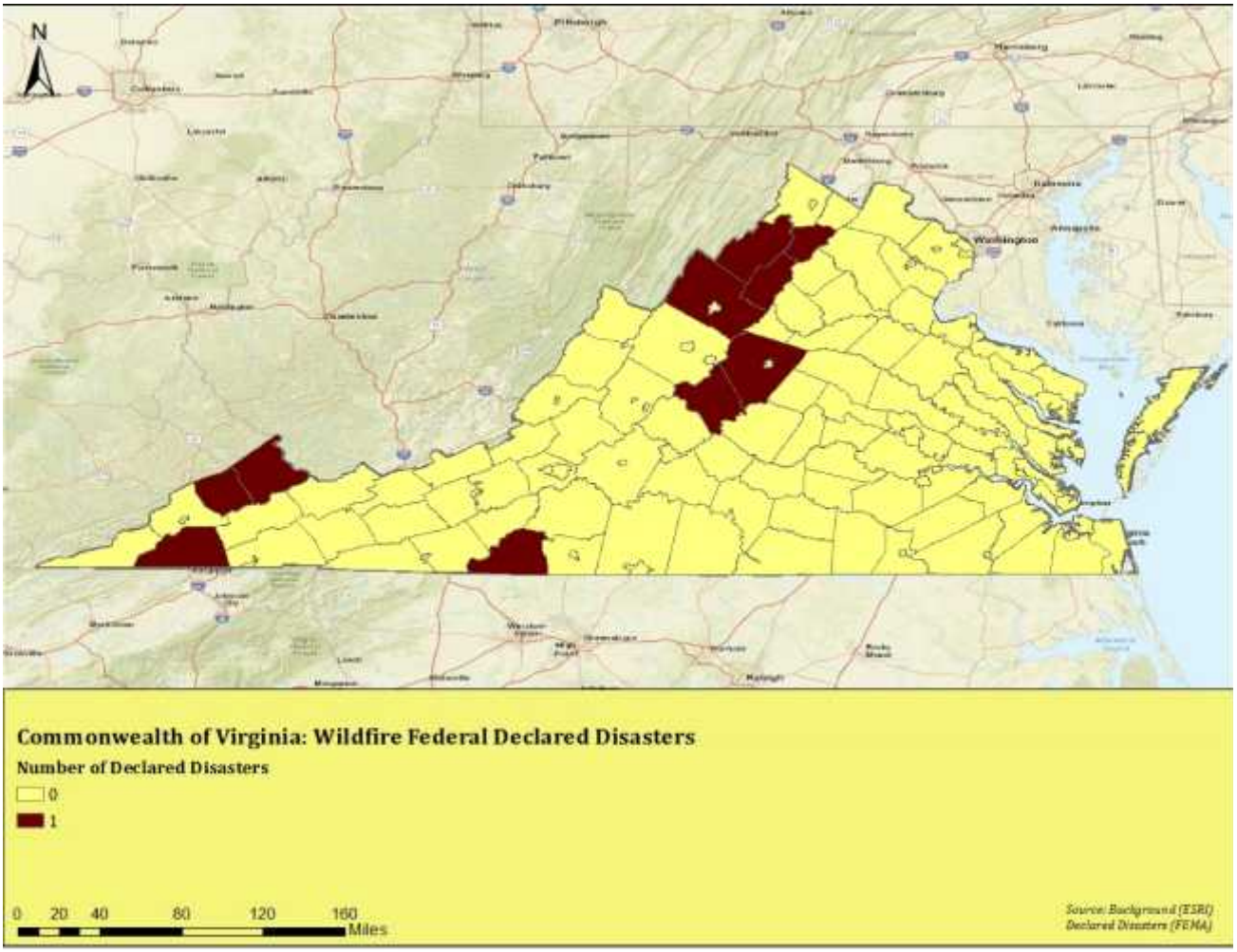


Figure 3.3-8: Landslide Federal Disaster Declarations

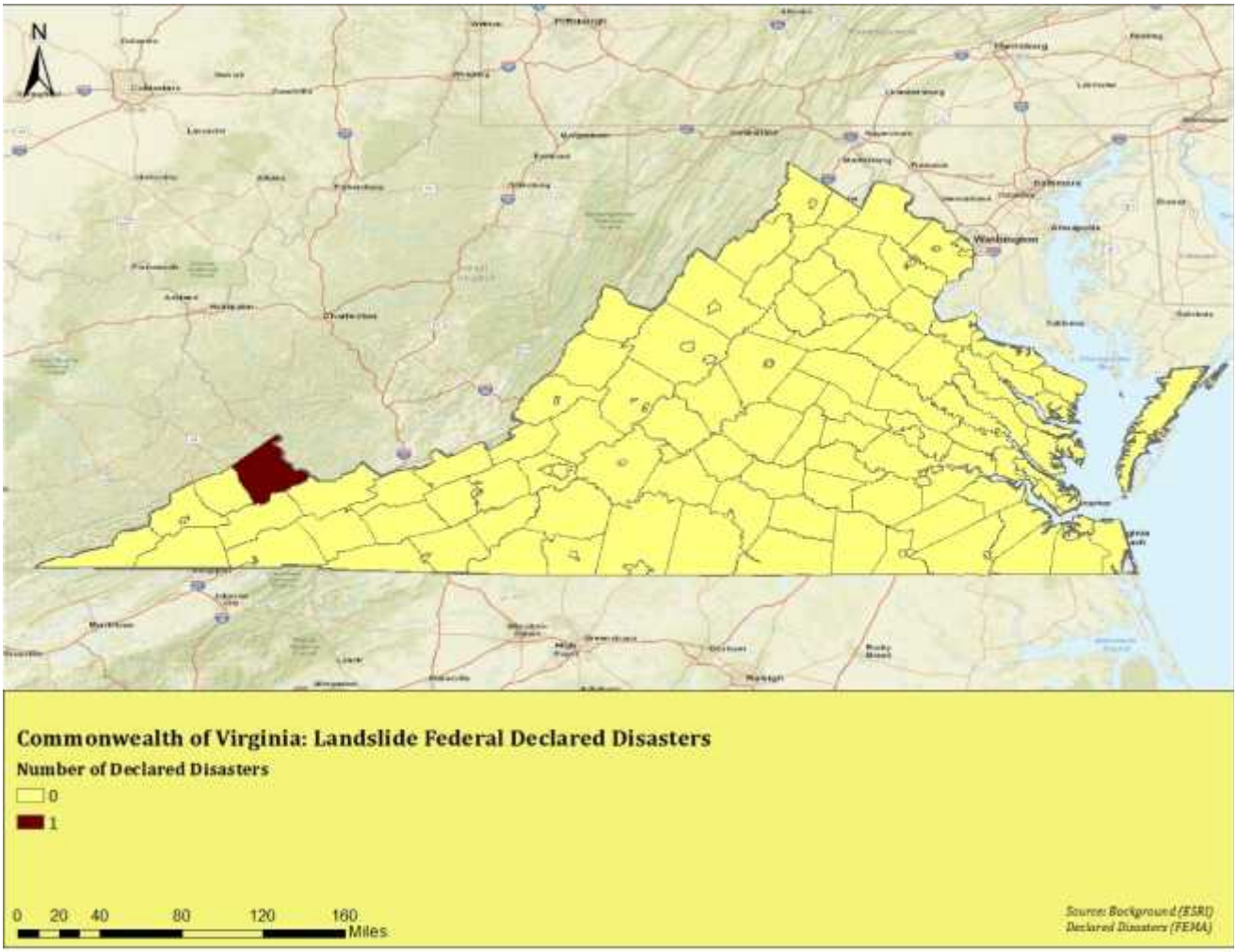
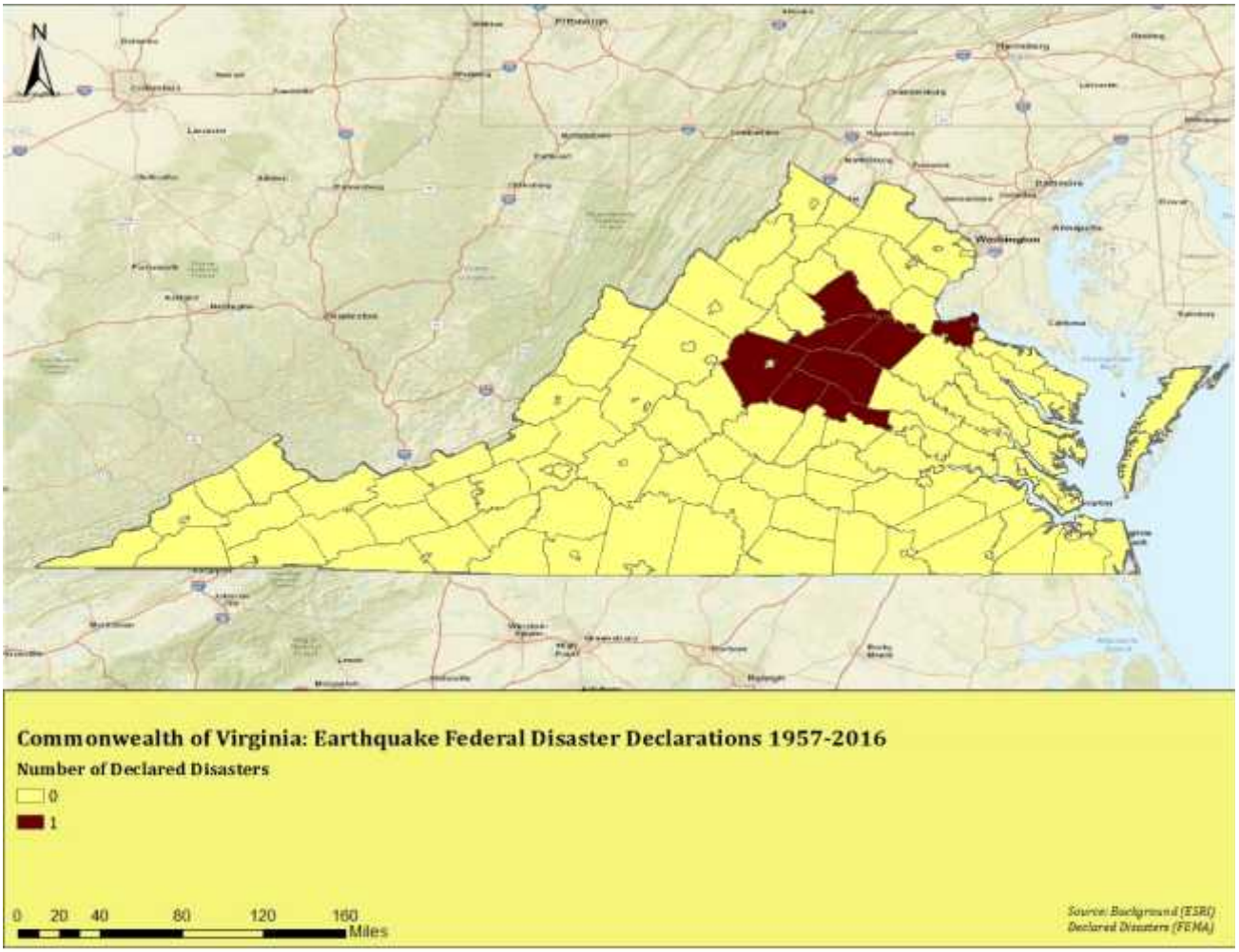


Figure 3.3-9: Earthquake Federal Disaster Declarations



National Centers for Environmental Information (NCEI)

(Note: since the 2013 plan, the National Climatic Data Center – NCDC – has been renamed as the National Centers for Environmental Information, or NCEI[11].)

NCEI Storm Data Background

National Center for Environmental Information (NCEI) *Storm Events Database* is published by the National Oceanic and Atmospheric Administration (NOAA), part of the US Department of Commerce. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce. Efforts are made to collect the best available information, but because of time and resource constraints, information may be unverified by the National Weather Service (NWS). The NWS does not guarantee the accuracy or validity of the information. Although the historical records in the database often vary widely in their level of detail, the NWS does have a set of guidelines used in the preparation of event descriptions[12].

For this update, Witt O'Brien's collected an export of the *Storm Events Database* records from NCEI, containing information about significant weather events from January 01, 1950 through December 31, 2016. Records for the majority of weather events were reported starting in 1993, with the exception of tornado (reports date to 1951), thunderstorm winds (reports date to 1955), and hail (reports date to 1955). Before the NCEI *Storm Events Database* data could be used for analysis, though, some additional processes were required.

For the purposes of this HIRA, the county/city in which the event occurred was of primary interest, and the NCEI has provided this data in two methods:

a) County/City Name – Event listed as individual record for each county or city in which it occurred.
b) Zone – Event listed by the zone or multiple zones, which contain multiple counties and cities. Some individual rows in NCEI data could include every county and city in Virginia.

NCEI is known to have spotty recording of geological hazards (i.e. earthquake, landslide, karst). In the absence of better data, it was determined to proceed with the records available in NCEI for these events, as in all cases NCEI records for these events are severe under-representations of what has happened in Virginia. To date, no comprehensive digital databases exist for these hazards.

NCEI Normalizing Data

In 2012, during the completion of the last update but after the data was pulled, major changes were made to the records maintained by NCEI (then NCDC). These changes resulted in revisions

to historic records in the database, as well as additional data being added to the database. Since this major effort in 2012, periodic additions of new data and revisions to existing data have been accomplished by NOAA/NCEI, with the benefit of creating a better dataset for general use.

Because of these changes, however, the data available from NCEI during this plan update was significantly different from the data that was available during previous plan updates; in general, it is much improved, with fewer duplicates and better assignment of impacted jurisdictions. As a result, all previous NCDC data has been removed from this plan update, and replaced with NCEI data. This resulted in different calculations and findings – in some cases significantly different – than were found in previous versions of this plan. However, the NCEI data contained in this plan update is the best available version of the best data available.

To be able to accurately count the number of events occurring in a single jurisdiction, the zonal data records were expanded into a set of individual city/county records, based on NCEI zone definitions. For example, if there were three political jurisdictions in the zone, a record in the database for a winter storm covering that zone would be replaced with three records for that storm, corresponding to each of the political jurisdictions. During this process, the damages and injuries associated with a storm event in a certain zone were divided evenly among the political jurisdictions in that zone. Table 3.3-3 (following) is the normalized sum of all the jurisdictions, by hazard, for the NCEI parameters of interest. In this table, the damages, injuries, and deaths due to each hazard type have not been annualized to account for their varying periods of record. Each event in this table represents a storm event affecting a single jurisdiction.

General time statistics were generated to determine how the different hazards were represented in the NCEI data. This consisted of developing percentile (tabular and graphical) and histograms of events versus date for each hazard type. For all events, the percentile graph was relatively linear. This suggests that reporting has remained roughly equal over the entire period of record, and all records should be counted.

Table 3.3-3: Total of jurisdictional analysis of NCEI results

Hazard Type	Timeframe	Years of Record	Number of Events	Property Damage	Crop Damage*	Injuries	Fatalities
Drought	1996-2016	20	2,252	$0	$527,365,000	292	9
Flood	1996-2016	20	5,419	$822,659,300	$70,758,000	18	60
Non-Rotational Wind	1950-2016	60	15,081	$1,518,539,187	$173,077,000	613	65
Tornado	1951-2016	65	848	$466,556,280	$2,622,000	935	37
Wildfire	1996-2016	20	46	$13,312,000	$1,587,000	8	0
Winter Storm	1996-2016	20	9,817	$61,349,900	$48,206,000	47	36
Landslide	1998-2016	18	4	$150,000	$0	0	0
		Totals	**33,467**	**$2,882,566,667**	**$823,615,000**	**1,913**	**207**

NCEI Inflation Computation

The damages entered into the NCEI *Storm Events Database* portray how much estimated damage was incurred in the year of the event. Due to inflation and the changing value of money, the values of damages incurred have been adjusted so that they reflect their worth in 2016. This process was done by obtaining information from the Bureau of Labor Statistics, which provides a yearly index of Consumer Prices. Each value was multiplied by the index of its year of occurrence and subsequently divided by the index value in 2016, the target year. The year 2016 was chosen because it was the most recent full year available in the index values list at the time of this writing, but the values could have been adjusted to any other year without changing the relative ranking of each hazard.

NCEI Annualizing Data

After the data was normalized, inflation accounted, and summary statistics calculated, the data was annualized to be able to compare the results on a common system (i.e. ranking the hazards). In general, this was completed by taking the parameter of interest and dividing by the length of record for each hazard. The annualized value should only be utilized as an estimate of what can be expected in any year. Fatalities/injuries, property and crop damage, and events were all annualized in this fashion, on a per-jurisdiction basis. The NCEI formatted data that was used in the analysis is available through VDEM.

NCEI Data Compilation

As the NCEI *Storm Events Database* uses detailed event categories, the reported storm events were summarized in simplified classifications to correspond to the major hazard types considered in this plan. Table 3.3-4 shows how the NCEI categories were grouped into the HIRA hazard categories. Section 3.5 on ranking methodologies also explains how the NCEI data was used in ranking the hazards against each other.

Table 3.3-4: NCEI categories to align with hazards addressed in the HIRA.

HIRA Category	NCEI Categories Included
Drought	Drought Excessive Heat Heat
Flood	Coastal Flood Flash Flood Flood Heavy Rain Storm Surge
High Wind	High Wind Hurricane (Typhoon) Marine High Wind Marine Strong Wind Marine Thunderstorm Wind Strong Wind Thunderstorm Wind Tropical Depression Tropical Storm
Tornado	Funnel Cloud Tornado Waterspout
Winter Storm	Avalanche Blizzard Cold/ Wind Chill Extreme Cold/Wind Chill Freezing Fog Frost/Freeze Ice Storm Sleet Winter Storm Winter Weather
Wildfire	Dense Smoke Wildfire
Landslide	Debris Flow

Figure 3.3-10 shows the number of NCEI hazard events, by jurisdiction, for the Commonwealth. High wind and winter storm events make up more than 70% of the events for the jurisdictions listed below. The following jurisdictions have 300 or more NCEI recorded events for drought, flood, high wind, landslide, tornado, wildfire, and winter storm.

- Albemarle County
- Augusta County
- Bedford County
- Campbell County
- Carroll County
- Clarke County
- Culpeper County
- Fairfax County
- Fauquier County
- Franklin County
- Frederick County
- Halifax County
- Henrico County
- Henry County
- Loudoun County
- Madison County
- Nelson County
- Orange County
- Page County
- Patrick County
- Pittsylvania County
- Prince William County
- Pulaski County
- Rappahannock County
- Roanoke County
- Rockbridge County
- Rockingham County
- Shenandoah County
- Spotsylvania County
- Stafford County
- Tazewell County
- Warren County

Figures 3.3-11 through 3.3-17 show the number of NCEI recorded events, by jurisdiction, for the individual hazard HIRA Categories. Unlike the federally declared disasters, the individual hazard maps do not double count events. To be consistent with the NCEI data, only the dominate hazard type is shown, as is described in the above sections and Table 3.3-4. (Note: the figures reference the dataset as NCDC rather than NCEI, as the name change occurred after the predominant period of record shown in the figures.)

High wind and winter weather represent the majority of the documented weather related events in Virginia. Land subsidence, earthquake, communicable disease, solar storm, and flooding due to impoundment failure are hazards that have been considered for the Commonwealth but currently do not have NCEI events associated with them.

Figure 3.3-10: Total NCEI Events

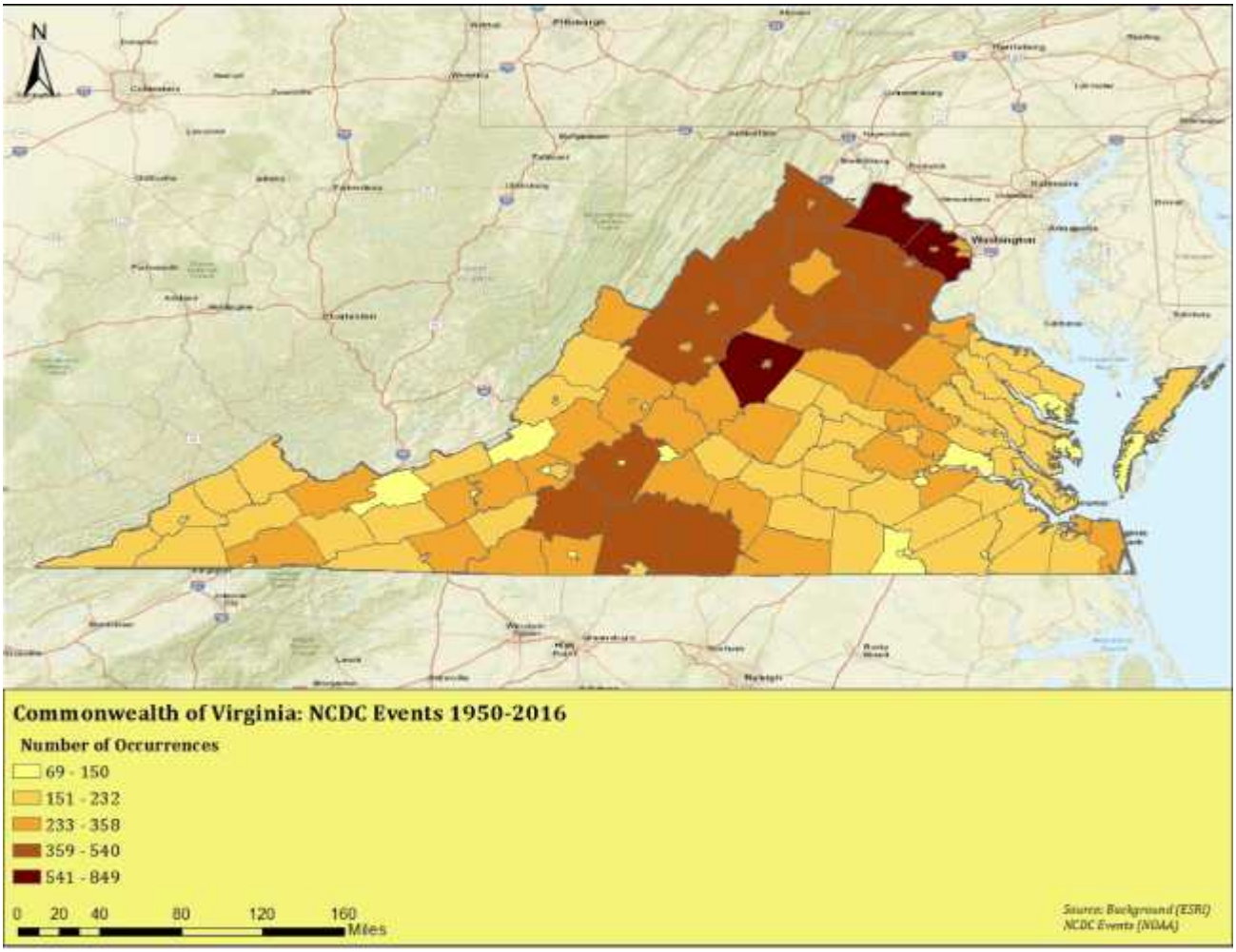


Figure 3.3-11: NCEI Significant Drought Events

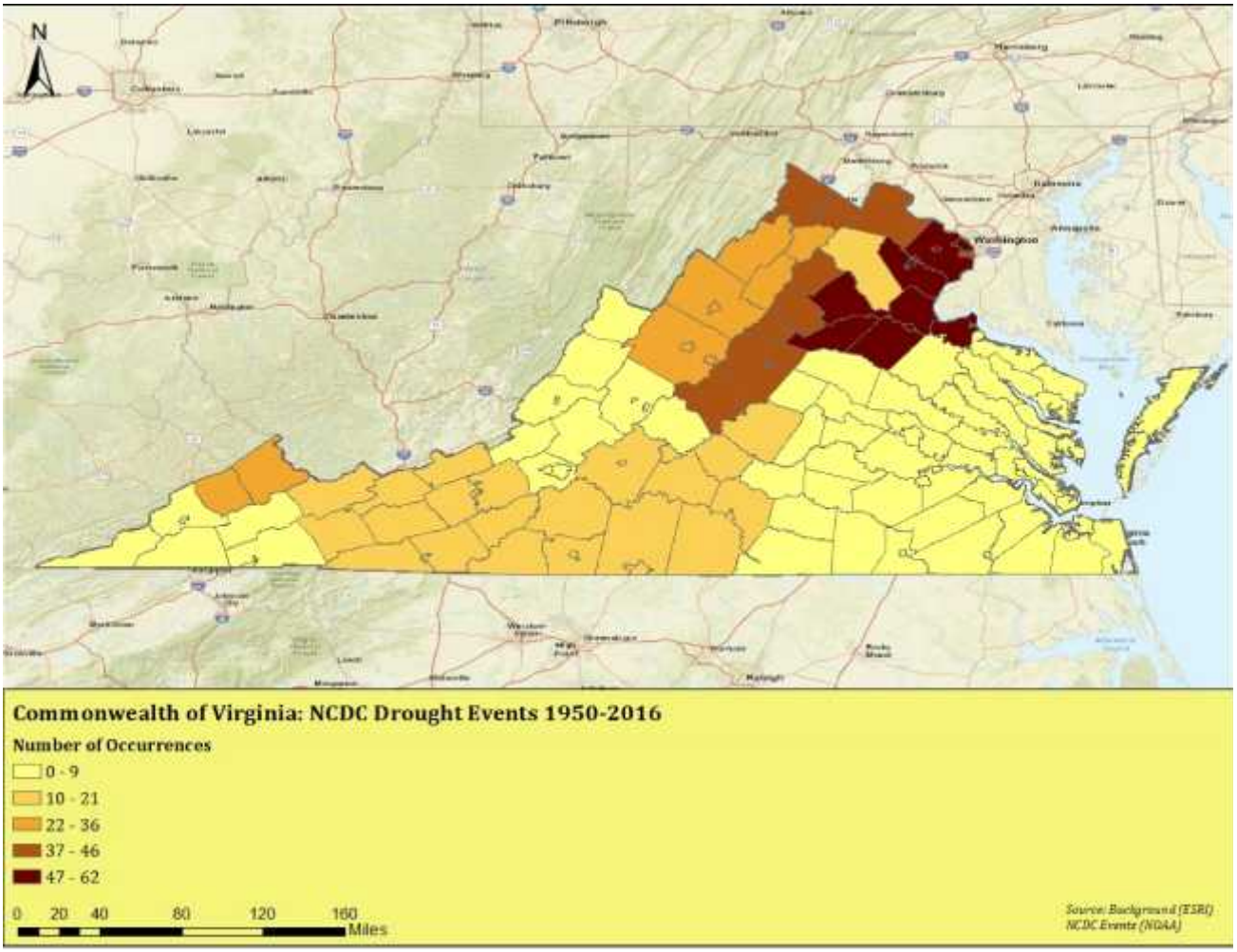


Figure 3.3-12: NCEI Significant Flood Events

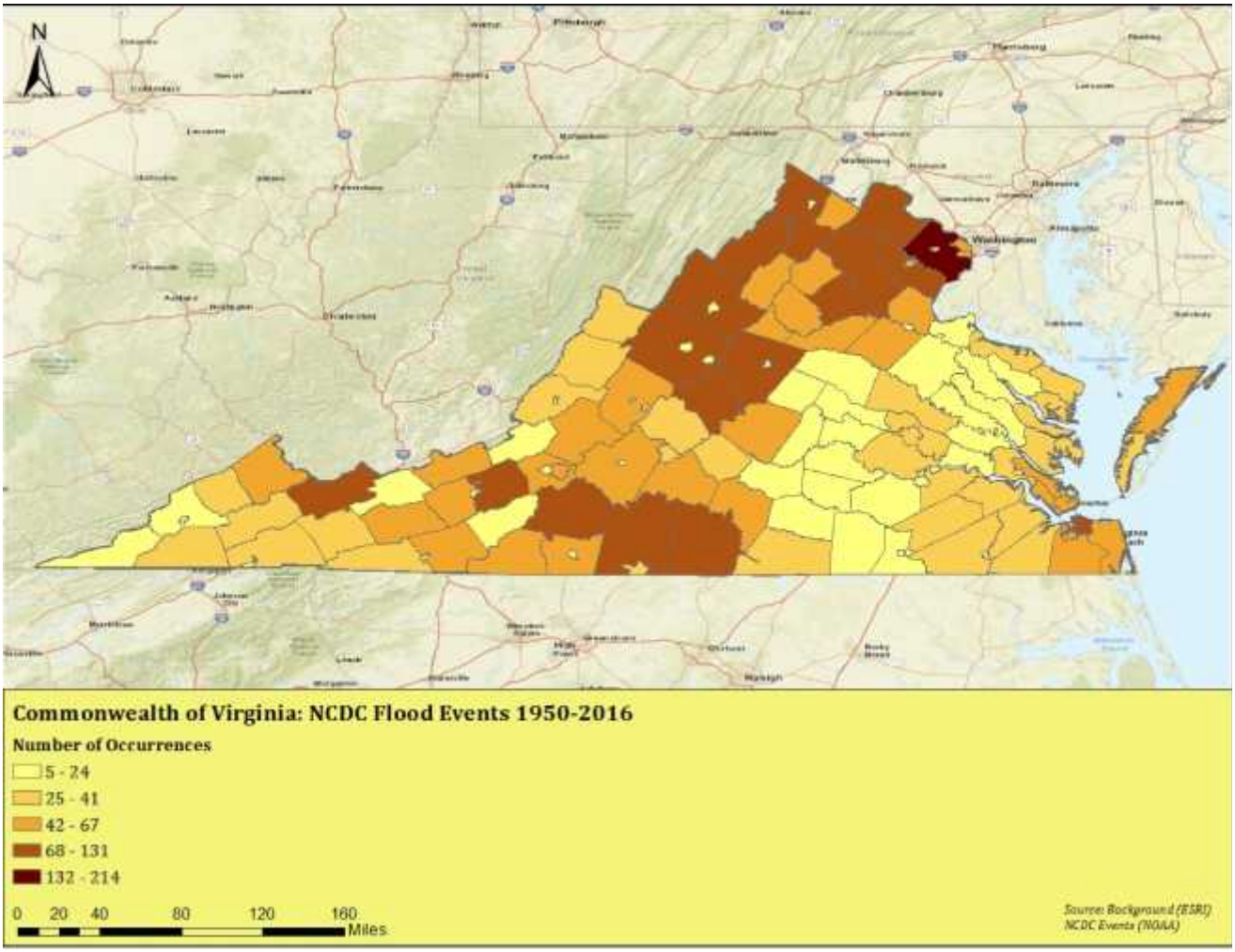


Figure 3.3-13: NCEI Significant Non-Rotational Wind Events

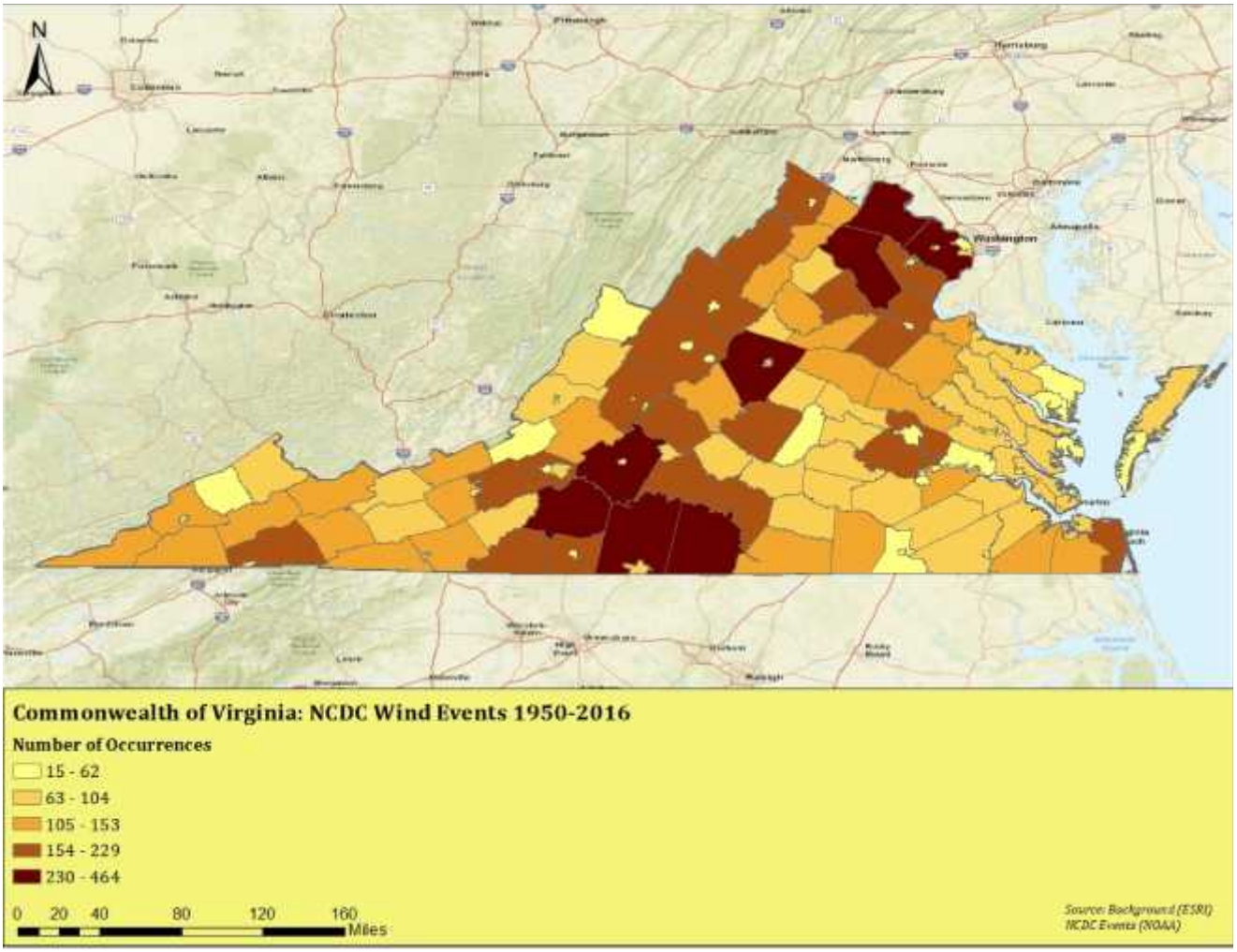


Figure 3.3-14: NCEI Significant Tornado Events

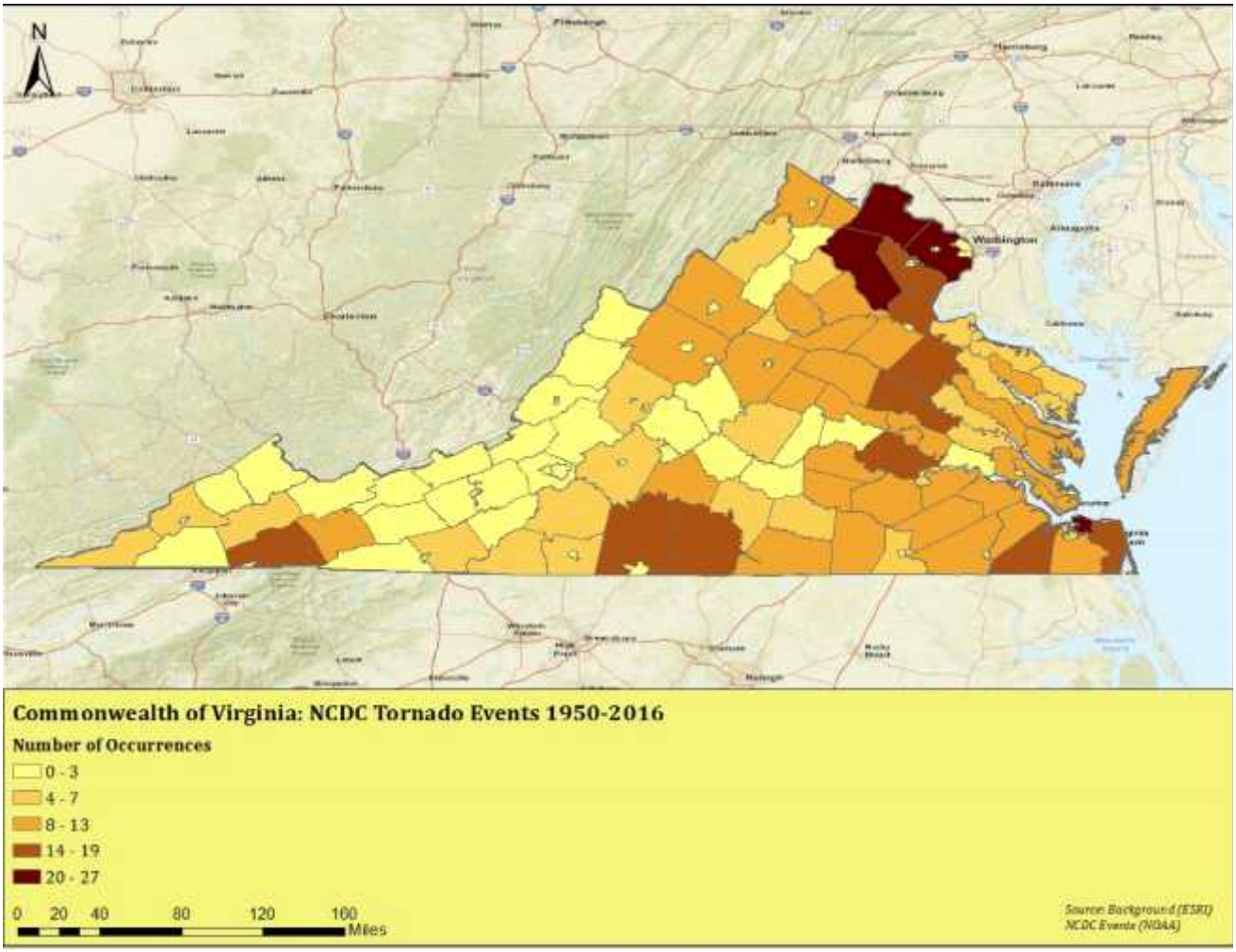


Figure 3.3-15: NCEI Significant Winter Weather Events

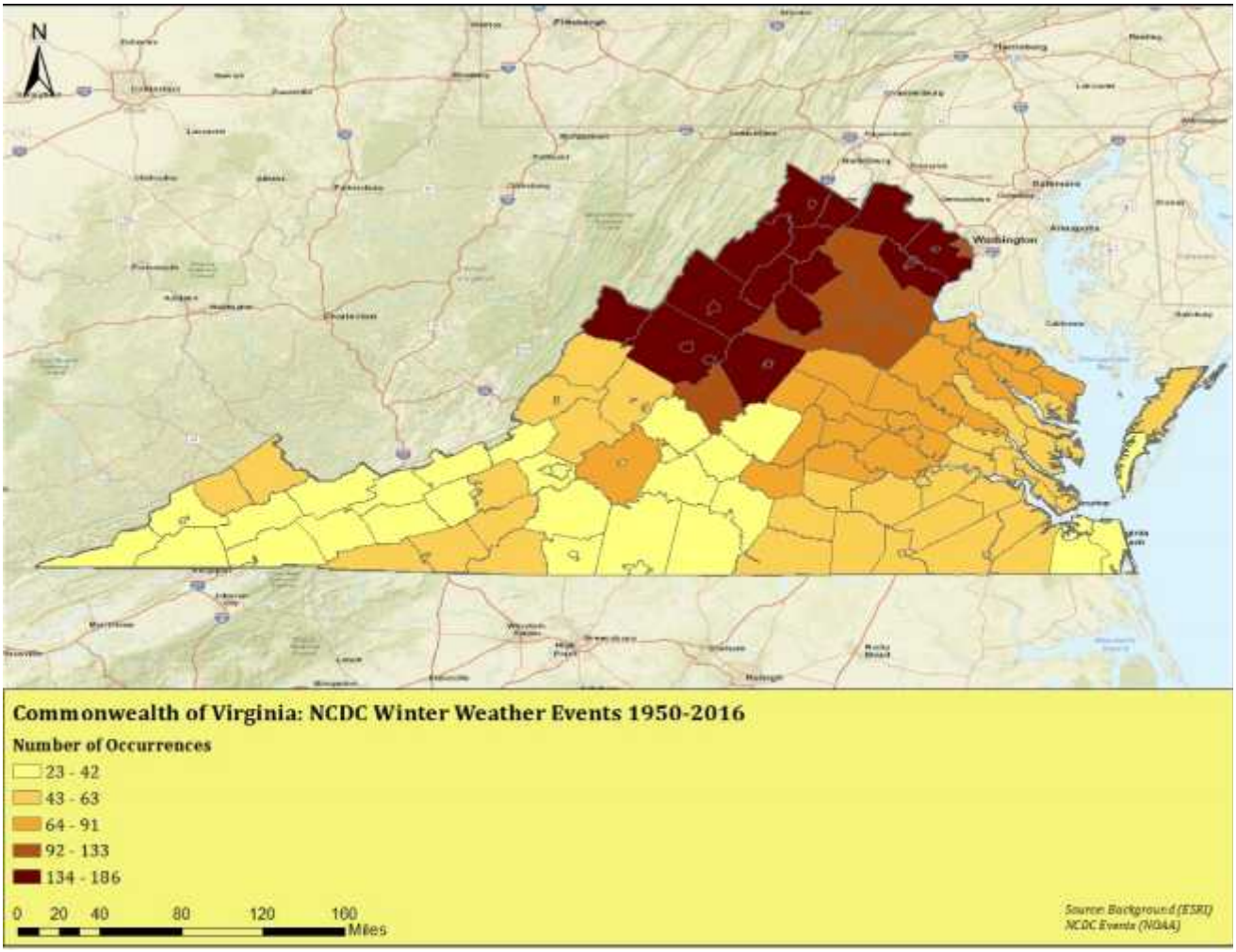


Figure 3.3-16: NCEI Significant Wildfire Events

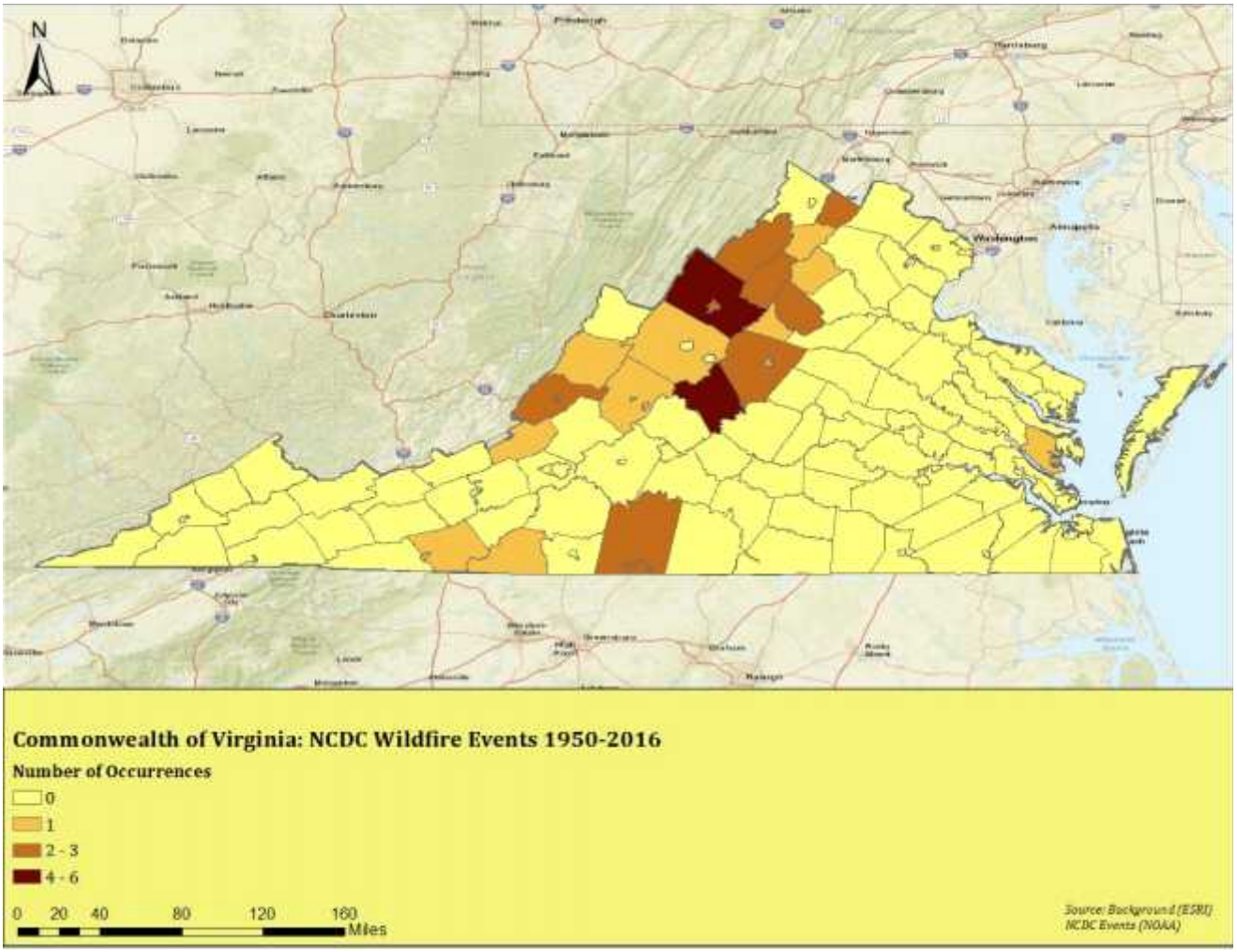
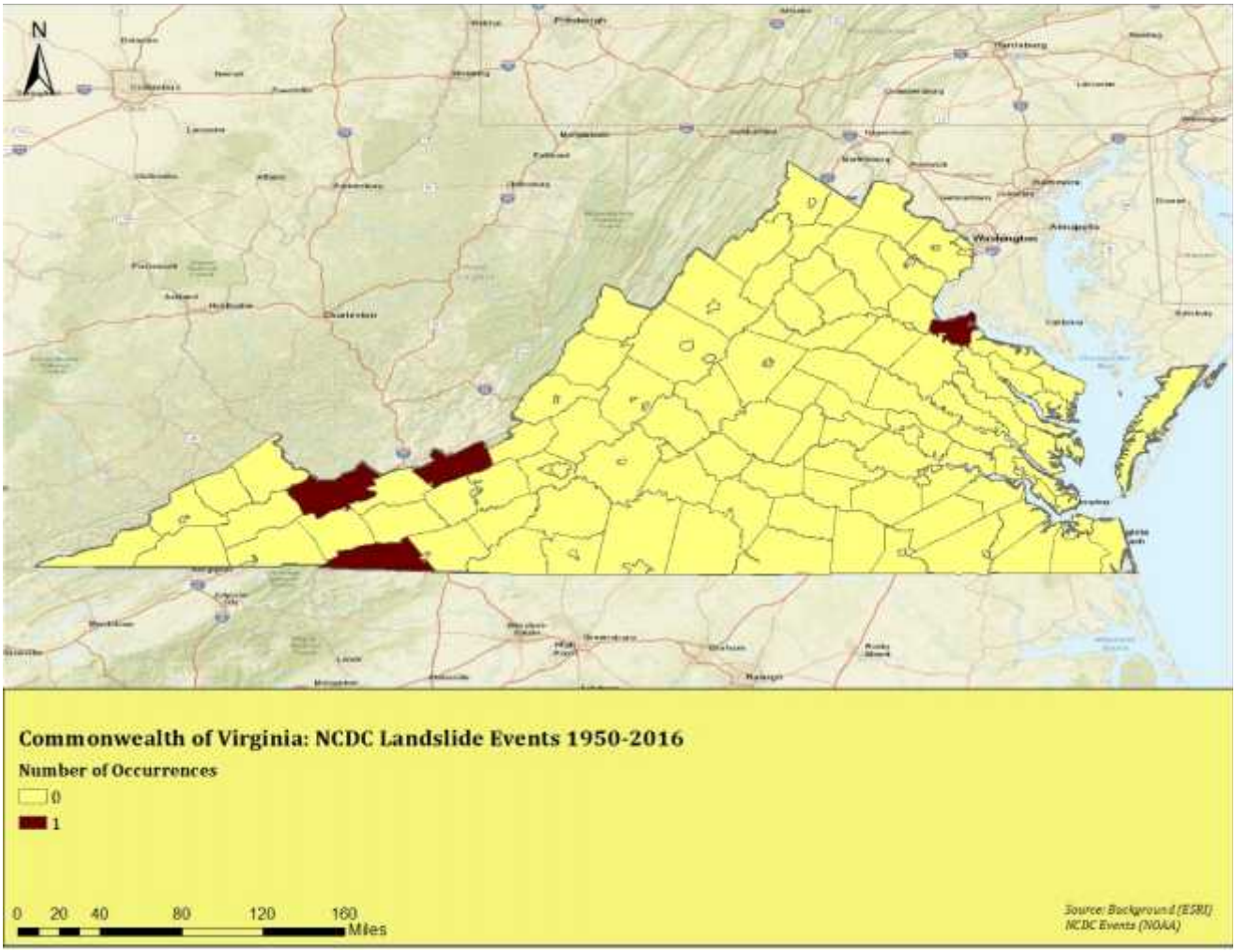


Figure 3.3-17: NCEI Significant Landslide Events



Endnotes

[1] *A Guide to the Disaster Declaration Process and Federal Disaster Assistance*. FEMA March 4, 2008.
[2] Virginia Department of Emergency Management. Retrieved from www.vaemergency.gov/news/2009/sbaOfferDisasterAssist
[3] Wunderground. *The 30 Costliest US Hurricanes.* Retrieved 06.12.17 from https://www.wunderground.com/hurricane/damage.asp
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[6] Virginia Department of Emergency Management. "FEMA Approves Federal Disaster Assistance for Local and State Governments Following Tropical Storm Lee".
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[8] Federal Emergency Management Agency. Retrieved 06.12.17 from https://www.fema.gov/disaster/4092
[9] Federal Emergency Management Agency. Retrieved 06.12.17 from https://www.fema.gov/disaster/4262
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[11] National Centers for Environmental Information. Retrieved 06.12.17 from https://www.ncdc.noaa.gov/about

[12] National Water Service Instruction 10-1605. Operations and Services Performance, NWSPD 10-16. March 23, 2016. Available at: http://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf

Section 3.4: State Facilities, Critical Facilities, & Energy Pipelines Analysis

In addition to examining vulnerability to jurisdictions, the HIRA also considers state facility and critical facility vulnerability. The HIRA does not consistently include local assessment information; local plan data was evaluated, but in most cases, was not included due to inconsistencies between the plans. See Section 3.6 for detailed information about the local plans and future mitigation action items to increase the usability of local plan data.

All state facility data was gathered by VDEM for this HIRA update. The HIRA examined two major sources of facility data: asset data provided by VDEM for state owned, leased, or managed facilities, and the federal HSIP Freedom geodatabase for critical facilities data. The facility data contained detailed location information for most assets, but did not contain any valuation information for any asset. The original dataset received also contained several non-improved land holdings; these were removed from the original dataset, and are not included in the updated analysis.

Many of the buildings in the VAPS database are critical to disaster preparedness and response, although not all critical facilities are in the VAPS database. For example, many privately owned buildings and structures (e.g., hospitals, power plants, certain industrial facilities, etc.) may be considered critical during certain natural disasters. As such, the critical facilities data collection has been used to represent a broader array of critical facilities than would be available through VAPS. However, as detailed in this section, the critical facilities data collection is a work-in-progress.

Additional types of linear infrastructure may also qualify as critical facilities, but were not assessed in this plan due to data and scope limitations. Historical road closure and condition reports were considered for use in this plan (as with the previous plan), but the format of the data posed challenges that limited its use. See later in this section for examples of the types of analysis that may be possible with this data in the future.

State Facilities

The original dataset obtained for this update contained information for over 13,800 locations for 247 state agencies, which includes public universities and colleges in Virginia. For the purposes of the risk assessment, the term state-owned facilities is used to refer to both state-owned and state-operated facilities. The dataset contained spatial location information for most assets; this information was used to intersect state assets with identified hazard zones. However, the dataset did not contain extensive attributes about each building or structure, such as basic structural information, construction type, building value, square footage, number of floors, year built, and sprinkler systems. A second dataset was later identified that did contain at least one valuation for

each asset, but did not contain any location information. There was not common identifier between the two datasets; therefore, they could not be married or joined together. As a result, no valuation estimated could be determined for state facilities in this plan update.

After the initial scrubbing, all remaining assets were assigned a category of use based on the primary function of that asset. These categories were used in mapping state assets. This grouping allowed for ease of mapping and limited symbology in mapping. Table 3.4-1 provides these categories and the number of facilities identified in each category.

Table 3.4-1: State Facilities and Numbers

State Facilities Categories	Total
Agriculture	317
Airfield	13
Animal Health	27
Armory	39
Barn	178
Childcare	10
Communications	76
Conference Center	15
Education	1,225
EMS	3
EOC	1
Fire Service	36
Food Service	88
Fuel	516
Hazmat	433
Historic	19
Housing	1,656
Library	29
Livestock	143
Medical Facility	125
Military	3
Museum	20
Office	1,260
Other	1,360
Parking	148
Public Safety	200
Readiness Center	30
Recreational	794
Research	178
Special Population	25

State Facilities Categories	Total
Storage	2,344
Student Services	53
Support	698
Toll	11
Utility	128
Visitors Center	46
Wastewater	68
Water	455
Closed	33
Total Facilities	**12,803**

Critical Facilities

There is currently no standard critical facility dataset for the Commonwealth; various plans have used different datasets, based upon the geographic and subject-matter scope of each plan. The 2013 plan used the Homeland Security Infrastructure Protection (HSIP) dataset, which is a national dataset, to identify critical facilities in the Commonwealth. At the time, critical facilities were grouped into six broad categories: law enforcement facilities, educational facilities, emergency response, transportation, and public health. The HSIP dataset contained general location information for each facility, but it did not contain attribute information such as building valuation, size, etc.

All critical facilities data for this plan update were determined from the state asset dataset. State assets were grouped into similar categories. Once asset categories were determined, some were further identified as critical. There are differences from the 2013 plan due to the use of a different dataset and the grouped assets within the available dataset. This version of the plan identifies the following broad types of critical facilities:

- Law Enforcement Facilities
- Special Populations Facilities
- Emergency Response
- Fuel Facilities
- Food Distribution/Service
- Utilities

The Commonwealth state asset database is the best available dataset since it is maintained at the State-level. However, this dataset has similar issues to the HSIP dataset, with lack of building valuation data, building size data, etc. Enhancement and continued maintenance of the dataset will lend to better risk assessment results in future plan updates.

Although not a complete representation of all the possible types of critical facilities, this data is a good representation of facility locations in the state. The database contains over 2,400 critical facilities within the six categories. Facilities are represented only as geographic points, and so the full spatial extent of larger facilities is not considered. Table 3.4-2 shows the number of facilities located in each critical facility category (with all categories used shown). The facilities data that was used in the analysis is available through VDEM.

Table 3.4-2: Critical Facility Type and Number of Mapped Facilities

Critical Facilities Categories	Total
Airfield	13
Animal Health	27
Armory	39
Childcare	10
Communications	76
EMS	3
EOC	1
Fire Service	36
Food Service	88
Fuel	516
Hazmat	433
Medical Facility	125
Public Safety	200
Research	178
Special Population	25
Utility	128
Wastewater	68
Water	455
Total Facilities	**2,421**

Energy Pipelines

Transmission and distribution pipelines are used to transport liquids and gases such as petroleum products, natural gas, and other chemicals across long distances. Virginia's economy and security benefits from the products transported via pipeline; this includes refined petroleum to fuel transportation systems, and natural gas to heat homes and generate power. However, these fluids are often hazardous to human health and/or to the environment, and so the operation of transmission pipelines is regulated to ensure public safety.

Applicable federal laws are found in U.S. Code, Title 49, Subtitle VIII, Chapter 601; regulatory activity occurs in accordance with Title 49 of the Code of Federal Regulations (CFR), Parts 190-199, and are carried out by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA). In Virginia, the State Corporation Commission's Division of Utility and Railroad Safety is also responsible for regulating certain operators, in coordination with PHMSA.

Risks associated with transmission pipelines result from accidental releases of the transported products, which can impact public safety, the environment, national security, and the economy. Accidental releases can result in injuries or fatalities from fires or explosions caused by ignition of the released product, as well as from possible toxicity and asphyxiation effects. Economic impacts may result from business interruptions, damaged infrastructure, and loss of fuel supplies.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) maintains the National Pipeline Mapping System (NPMS), a nationwide GIS database of transmission energy pipelines with attribute information such as the pipeline operator (typically a private business) and the type of material transported. The database does not include detailed valve, facility, or operational details, nor does it include distribution or gathering pipelines. Map features in the NPMS typically have an accuracy of +/- 500 feet, so the database is useful for a general assessment of pipelines, but not for engineering work like excavation planning. The Pipeline Safety Improvement Act of 2002 required pipeline operators to begin submitting geospatial data to the NPMS. Due to security concerns, the distribution of NPMS data is limited to federal, state, and local government agencies. The NPMS Public Map Viewer allows the public to view maps of transmission pipelines, LNG plants, and breakout tanks in one selected county[1].

PHMSA also tracks pipeline incidents such as breaks or spills; PHMSA defines Significant Incidents as those incidents reported by pipeline operators when any of the following specifically defined consequences occur[2]:

1. fatality or injury requiring in-patient hospitalization
2. $50,000 or more in total costs, measured in 1984 dollars

3. highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
4. liquid releases resulting in an unintentional fire or explosion

Table 3.4-3: Significant Pipeline Incidents Caused by Natural Hazards in Virginia (2001-2016)[3]

Year	Location	Operator	Property Damage	Sub-Cause
2001	City of Richmond	Richmond Dept. of Public Utilities	$124,418	Earth Movement
2007	City of Richmond	Transmontaigne Product Services Inc.	$1,086	Lightning
2010	Charlotte Courthouse	Colonial Pipeline Co.	$123,396	Temperature

As of this plan update, there are approximately 3,517 miles of active or idle transmission pipelines in Virginia, carrying natural gas, petroleum-based fuels, and other gases.

Analysis

The results of the risk assessment for state facilities, critical facilities, and energy pipelines are included in the risk assessment section of each individual natural hazard. Facilities were intersected with the hazard's Geographic Extent (GE) layer to determine the buildings risk zone. The analysis methodology is described in full detail in the individual hazard sections; tables are used to represent the number of facilities in each risk category.

Potential dollar loss to state facilities was completed for some of the hazards. Total exposed building value has been denoted for all the addressed hazards. Agencies with a large quantity of structures or building value in the high-risk hazard areas are noted in each of the sections. These agencies and buildings are an excellent starting point for assessing the need for specific mitigation action items.

In depth analysis could not be completed for the critical facilities because of the lack of building specific details, as previously discussed.

Pipelines may be impacted by natural hazards in direct and indirect ways. An example of a direct impact would be erosion or shifts in the supporting soils resulting in pipeline collapse. Indirect impacts are those that affect the infrastructure that supports pipeline operations. An example of an indirect impact would be severe storms causing a general power or communication systems failure which, while not impacting the structural integrity of the pipeline, could disrupt the pipeline operator's ability to operate the pipeline safely and the pipeline may be required to be

shutdown. Hazard-specific summaries of pipeline impacts are included in the individual hazard sections, where applicable.

HAZUS-MH

HAZUs-MH is FEMA's nationwide standardized loss estimation software package, built upon an integrated GIS platform with a national inventory of baseline geographic data (including information on Virginia's general building stock and dollar exposure). Originally designed for the analysis of earthquake risks, FEMA has expanded the program to allow for the analysis of multiple hazards including flood and wind events. By providing estimates on potential losses, HAZUS-MH facilitates quantitative comparisons among hazards and may assist in the prioritization of hazard mitigation activities.

HAZUS-MH uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The HAZUS-MH risk assessment methodology includes distinct hazard and inventory parameters. For example, wind speed and building type were modeled using the HAZUS-MH software to determine the impact (damages and losses) on structures.

This plan update utilized HAZUS-MH to produce regional profiles and estimated losses for hurricane wind hazards. HAZUS-MH was used to generate probabilistic 'worst case scenario' events to show the maximum potential extent of damages. It is understood that those events of less severe magnitude which could occur would likely result in fewer losses than those calculated here. In addition, a statewide scenario for earthquake was developed and included in the risk assessment.

Future Mitigation Actions

Proposed mitigation actions address the need for a more complete critical facility database, an enhanced state facility database, and an energy gathering pipeline facility database. VDEM should consider standardizing the definition of a critical facility for local plan revisions, and provide advice on the essential attributes to be collected. This would act as a template for local plans to follow in the future. An option could include the FEMA HAZUS-MH software which is currently evolving into the Comprehensive Data Management System (CDMS) that could be used as a template for this data collection process.

Endnotes

[1] NPMS Public Map Viewer is available at: https://www.npms.phmsa.dot.gov/PublicViewer/
[2] US Department of Transportation. Pipeline & Hazardous Materials Safety Administration. "PHMSA Stakeholder Communications." http://primis.phmsa.dot.gov/comm/reports/safety/sigpsi.html?nocache=9177
[3] US Department of Transportation. Pipeline & Hazardous Materials Safety Administration. "PHMSA Stakeholder Communications." http://primis.phmsa.dot.gov/comm/reports/safety/IncDetSt_st_VA_flt_sig.html?nocache=9782

Section 3.5: Hazard Assessment and Ranking Methodology

This chapter describes the concepts underlying the hazard identification and risk assessment process, and the methods used to rank hazard risk. These concepts underlie the individual hazard chapters that follow. The Advisory Committee and the Working Group reviewed the process used to identify the hazards during the kickoff meeting in February 2017, and validated it as acceptable for this plan update.

Criteria for Hazards, Vulnerability, and Risk Assessment
The following risk assessment has been structured to identify:

1. Geographic Area Affected
2. Historical Occurrences
3. Probability of Future Events
4. Vulnerable Populations

For the purposes of compliance with the Disaster Mitigation Act as further specified by 44 CFR, §206.401(c)(2)(i), this Plan addresses in full only the hazards in section 3.1 of this chapter. Additional hazards will be more fully addressed during plan updates as their respective significance warrants.

Terminology
The definition of terms can cause confusion in mitigation planning. This is evident in the review of 20 local mitigation plans, in which definitions of key terms varied substantially. Section 3.6 of this chapter describes the local planning efforts and the hazards addressed by each planning area.

Maintaining clear terminology in the 2018 SHMP revision process is a priority. To improve consistency, the following discussion identifies working definitions and expanded meanings of key terms as found in references consulted during the exploration of this issue.

Probability
In this plan, probability is the odds (or chance) of a certain event, of a certain magnitude, occurring in each period. In the strictest sense, probability must be expressed with a quantitative statement of chance. However, when the exact probability has not been studied, a qualitative statement of risk must suffice.

Two primary methods exist for determining the probability of a hazard's occurrence: statistical analysis of historical occurrences and models of probable occurrence.

Statistical analysis of historical occurrence can be applied to large databases. These databases may include the time, intensity, location, and damages caused by an event. Examples of such databases include weather conditions, wildfire occurrences, and sinkhole reports. Determining the historic frequency of occurrence of certain events may be sufficient to estimate future rates of occurrence, if the event occurs at a relatively steady rate. However, a major drawback to this method of probability estimation is that errors, biases, and incomplete reporting in the historical database can lead to inaccurate projections.

In contrast to pure statistical analysis, models of probable occurrence predict hazard probability based on a more theoretical basis. While many models are often calibrated to historical data, they have the capability to predict occurrences that would not be otherwise observed, due to the lack of witnesses for extremely rare events. Examples of such models include flood maps depicting 1% and 2% annual chance floodplains (100 and 500-year), storm surge inundation models, karst susceptibility maps based on geologic conditions, fire risk, and many others.

The desired result of a probability analysis is the creation a dataset that communicates not only the probability of occurrence, but also the spatial extent and intensity. A statement of probability alone, without some associated intensity, is not always useful if the hazard in question occurs frequently, and with widely varied intensity.

Vulnerability & Impact

> *§201.4(c)(2)(ii) [The state plan shall have] An overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed.*

Vulnerability may be defined as the degree to which a certain receiving body may be damaged by a hazard event. Jurisdictional vulnerability is often directly related to the number and type of people in certain hazard-prone areas. Facility vulnerability, on

the other hand, may be directly related to structural capacity, fire suppression systems, and other reinforcements against hazards.

Within jurisdictional vulnerability, special attention may be paid to social vulnerability. Certain members of a society are more vulnerable to disaster events for various reasons. Future revisions to this plan should include this as a factor of vulnerability. Several studies outline methods to consider socioeconomic status when calculating the overall vulnerability of a certain geographic location. One particularly promising analysis method creates a social vulnerability index using readily available US Census data and has been used in several other hazard risk assessments[1].

This report analyzes both jurisdictional and facility-specific vulnerability. Jurisdictional vulnerability includes population and other demographic factors, aggregated building values, and the net numbers of local critical facilities impacted by a potential hazard. Facility-specific vulnerability is the result of the physical properties of a facility: the construction type, standards, and age; elevation and number of stories; fire suppression; and various other factors. Ultimately, vulnerability is often summarized in the form of an intensity-damage relationship developed from an analysis of historical hazard impacts.

Impact may be defined as the actual effect of a hazard event on a certain receiving body. Jurisdictional impact could be quantified as the actual number of people affected by an event, or other measures of the effect of the hazard on the jurisdiction. Facility impact could be the financial losses that occur because of damage to the facility by a well-defined hazard event.

Impact is difficult to accurately predict from a purely theoretical perspective. Usually, historical data is analyzed to assess quantified damages, deaths, and injuries that result from specific events of specific intensities. This analysis may result in intensity-damage relationships which can be used to estimate the impact of specific hazard scenarios in the future.

Risk

Risk is “the estimated impact…[and]…the likelihood of a hazard event…” Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a threshold. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard[2].

The risk associated with a certain hazard can also be described as the probability of that hazard's occurrence multiplied by its impact. When probability is expressed as annual chance, risk may be calculated as annualized loss. For many hazards, different probabilities may be associated with varying intensities. In these cases, the combined risk due to a certain hazard is equal to the sum of the risk associated with each intensity level.

Ranking Methodology

To compare the risk of different hazards, and prioritize which are more significant, requires a system for equalizing the units of analysis. Under ideal conditions, this common unit of analysis would be 'annualized dollars.' However, such an analysis requires reliable probability and impact data for all the hazards to be compared. As this is often not the case, many hazard prioritization methods are based on scoring systems, which allow greater flexibility, and more room for expert judgment.

VDEM developed a standardized methodology to compare different hazards' risk on a jurisdictional basis. As some of the hazards assessed in this plan did not have precisely quantifiable probability or impact data, a semi-quantitative scoring system was used to compare all the hazards. This method prioritizes hazard risk based on a blend of quantitative factors from the available data. Several parameters have been considered in this methodology, all of which could be derived from the NCEI database (Section 3.3):

- History of occurrence
- Vulnerability of people in the hazard area
- Probable geographic extent of the hazard area
- Historical damages, in terms of crop and property

The ranking methodology tries to balance these factors, whose reliability varies from hazard to hazard due to the nature of the underlying data. Each parameter was rated on a scale of one (1) through four (4). The exact weights were highly debated, but the conclusion was that the population vulnerability and density would each be weighted at 0.5 and geographic extent at 1.5, relative to the other parameters. These scores are summed at a jurisdictional level for each hazard separately, permitting comparison between jurisdictions for each hazard type. A summation of all the scores from all hazards in each jurisdiction provides an overall, 'all-hazards' risk prioritization. The following sections provide an overview of the six parameters that were used in ranking the hazards that impact Virginia.

The NCEI data, as described in Section 3.3, is far from a complete data source. This data was used for the ranking because of its standardized collection of many of the hazards of interest. The data only partially represents the geological hazards and thus the ranking can only characterize the current form of the data. As other data sources become available the ranking will need to be reassessed to make sure the parameters are still valid for ranking the hazards.

Population Vulnerability and Density

Population vulnerability and density are simple, yet important factors in the risk ranking assigned to a jurisdiction. In general, a hazard event that occurs in a highly populated area has a much higher impact than a comparable event that occurs in a remote, unpopulated area. Two population parameters were used, accounting for jurisdictions with high populations and jurisdictions with densely populated areas. Each parameter was given a weighting of 0.5 to avoid overwhelming the overall ranking methodology with pure population data.

Population vulnerability was calculated as the percent of the total population of Virginia present in each jurisdiction. The 2015 US Census population estimate for each jurisdiction was divided by the total population for the state; a value between one and four was assigned based on a geometric breaks pattern. By ranking jurisdictions this way, those cities and counties with significantly larger populations have effectively been given extra weight. Table 3.5-1 describes the breaks and assigned scores for population vulnerability.

Table 3.5-1: Population Vulnerability as the percentage of people that will be affected by the occurrence of the hazard

Population Vulnerability	
Rank	Definition
1	<= 0.229 % of the total population of the state
2	0.230% - 0.749% of the total population of the state
3	0.750% - 2.099% of the total population of the state
4	> = 2.100% of the total population of the state

Population density was based on the population per square mile for each jurisdiction. 2015 population estimate data for each jurisdiction was divided by the total area for the jurisdiction; a value between one and four was assigned based on geometric intervals. By ranking jurisdictions this way, those cities and counties with densely populated areas have effectively been given extra weight. Table 3.5-2 describes the breaks and assigned scores for population density.

Table 3.5-2: Population Density as the number of people per square mile that will be affected by the occurrence of the hazard

Population Density	
Rank	Definition
1	<= 60.92 people/sq mi
2	60.93 – 339.10 people/sq mi
3	339.11 - 1,743.35 people/sq mi
4	>= 1,743.36 people/sq mi

Geographic Extent

Probable geographic extent (GE) would ideally be measured consistently for each hazard; however, the available data sources vary widely in their depiction of hazard geography. Thus, one uniform ranking system could not be accomplished now. In this version of the plan each hazard has been assigned individual category break points based on the available hazard data. In the overall scoring system, geographic extent was given a 1.5 weighting relative to the other parameters, as geographic extent was deemed to be critically important, and more reliable than some of the other parameters. GE data sources, ranking criteria, and category breaks are summarized in Table 3.5-3.

Table 3.5-3: Geographic Extent as the percentage of a jurisdiction impacted by the hazard

Geographic Extent			
Hazard	**Description**	**Category Breaks**	
		Rank	Definition
Flood	Percent of a jurisdiction that falls within FEMA Special Flood Hazard Area (SFHA). *Data: FEMA Floodplains (DFIRMs)*	1	<=2.99%
		2	3.00-4.99%
		3	5.00 -9.99%
		4	>=10.00%
High Wind	Average maximum wind speed throughout the entire jurisdiction. *Data: HAZUS 3-second Peak Gust Wind Speeds*	1	<= 59.9
		2	60.0 - 73.9
		3	74.0 - 94.9
		4	>= 95.0
Wildfire	Percent of jurisdiction that falls within a “high” risk. *Data: VDOF Wildfire Risk Assessment*	1	<= 9.9%
		2	10.0% - 19.9%
		3	20.0% - 49.9%
		4	>= 50.0%

Geographic Extent			
Hazard	**Description**	**Category Breaks**	
		Rank	Definition
Karst	Percent of jurisdiction where the risk is "high" for karst related events. *Data: USGS Engineering Aspects of Karst*	1	<= 24.9%
		2	25.0% - 49.9%
		3	50.0% - 74.9%
		4	>= 75.0%
Landslide	Percent of jurisdiction where a high landslide risk exists. *Data: USGS Landslide Incidence & Susceptibility*	1	<= 24.9%
		2	25.0% - 49.9%
		3	50.0% - 74.9%
		4	>= 75.0%
Earthquake	Average 2500-year return period max percent of gravitational acceleration (PGA). *Data: HAZUS 2500-year PGA*	1	<= 0.069
		2	0.070 - 0.159
		3	0.160 - 0.299
		4	>= 0.300
Winter Storm	Average annual number of days receiving at least 3 inches of snow, calculated as an area-weighted average for each jurisdiction. *Data: NWS snowfall statistics*	1	<= 1.49
		2	1.50 - 1.99
		3	2.00 - 2.99
		4	>= 3.0
Tornado	Annual tornado hazard frequency (times one million), calculated as an area-weighted average for each jurisdiction. *Data: NCEI tornado frequency statistics*	1	<= 1.24
		2	1.25 - 9.99
		3	10.00 - 99.9
		4	>= 100.00

Annualizing the Data for Analysis

Data from the NCEI database was annualized to be able to compare the results on a common system. In general, this was completed by taking the parameter of interest and dividing by the length of record for each hazard. The annualized value should only be utilized as an estimate of what can be expected in each year. Property and crop damage were annualized in the fashion. A summary of the parameters and the period of record used for each hazard can be found in the Section 3.3 which further describes the NCEI data.

Annualized Fatalities and Injuries

Fatalities and injuries are also an important factor to evaluate when determining risk ranking. Using NCEI data, past deaths and injuries were computed for drought, flood, high wind, tornado, wildfire, and winter storm. The remaining hazards have no

reported deaths or injuries in this database and thus were assigned a ranking of one (1). The combined injury/death values were annualized over the period of record for each event category and scored, using natural breaks (Table 3.5-4). A summary of deaths/injuries and the period of record used for each hazard can be found in the section 3.3 (Table 3.3-3) which describes the NCEI data.

Table 3.5-4: Annualized Fatalities and Injuries as the number of deaths or injuries that a hazard event would likely cause in each year.

Annualized Fatalities and Injuries	
Rank	Definition
1	<= 1.019 fatalities and/or injuries per year
2	1.020 – 6.279 fatalities and/or injuries per year
3	6.280 – 13.199 fatalities and/or injuries per year
4	>= 13.200 fatalities and/or injuries per year

Annualized Crop and Property Damage

Crop damage and property damage were also analyzed separately to give each jurisdiction a score of one (1) to four (4). This data was obtained from the NCEI storm events database and annualized according to the period of record for each event category (Table 3.5-5).

The period of record in NCEI varies dramatically by hazard type. A summary of crop and property damages and the period of record used for each hazard can be found in the section 3.3 (Table 3.3-3) which describes the NCEI data.

Table 3.5-5: Annualized Crop and Property Damage as the estimated damages that a hazard event will likely cause in each year

Annualized Crop and Property Damage		
Rank	Definition: Crop Damage	Definition: Property Damage
1	<= $25,711 per year	<= $ 136,129 per year
2	$25,712 – $100,270 per year	$136,130 - $432,555 per year
3	$100,271 - $291,384 per year	$432,556 - $1,111,067 per year
4	>= $291,385 per year	>= $1,111,068 per year

Annualized Events

While each hazard may not have a comprehensive database of past historical occurrences, the record of historical occurrences is still an important factor in determining where hazards are likely to occur in the future. Annualizing the NCEI

storm events data yields a rough estimate of the number of times a jurisdiction might experience a similar hazard event in any given year. To do this, the total number of events in the NCEI database, for each specific hazard in each jurisdiction, was divided by the total years of record for that hazard to calculate an annualized events value. A summary of events and the period of record used for each hazard can be found in the section 3.3 (Table 3.3-3) which describes the NCEI data.

It should be noted that there were no significant events reported for land subsidence (karst), earthquake, and landslide in NCEI; thus, the events for these hazards all received a rank of one (1). Table 3.5-6 describes the annual frequency breaks for events.

Table 3.5-6: Annualized Events as the number of times that a hazard event would likely happen in each year.

Annualized Events	
Rank	Definition
1	<= 0.09 events per year
2	0.10 – 0.99 events per year
3	1.00 – 4.99 events per year
4	>= 5.00 events per year

Overall Hazard Ranking

The scores from each of these categories were added together for each hazard to estimate the total jurisdictional risk due to that hazard. As discussed previously, the population parameters were each given a weighting of 0.5 (for a total of 1.0 for all population parameters), and Geographic Extent was given a weighting of 1.5 relative to the other factors. The total scores were broken into five categories to better illustrate the distribution of risk scores. Those jurisdictions with scores from 0 to 1.5 were determined to have a low risk in that hazard category, scores 1.60 through 2.49 were considered medium-low risk, between 2.50 and 3.59 medium risk, between 3.60 and 3.99 were considered medium-high risk; and jurisdictional hazard scores greater than 4.00 were given a high rating.

The appendix includes the ranking spreadsheet and the established values/rank for all the parameters by jurisdiction.

Endnotes

[1] Susan L. Cutter, et al. Social Vulnerability to Environmental Hazards Social Science Quarterly, 2003
[2] FEMA Publication 386-2: *Mitigation Planning How-to-Guide: Understanding Your Risks*

Section 3.6: Local Plan Incorporation

Summary of Planning Efforts

Virginia currently has 20 local hazard mitigation plans that have been submitted and approved by VDEM and FEMA Region III. There are 11 plans that either have expired or will expire in 2017 and are currently being revised or will soon be revised. These plans will be submitted to FEMA for review and approval as they are completed. The following section addresses local hazard identification, vulnerability and potential losses based on estimates provided in local risk assessment. In this revision of the plan, these results were not compared in detail to the statewide risk assessment because of data inconsistencies.

In addition to FEMA requirements for risk assessments, the Virginia Department of Emergency Management (VDEM) has additional requirements for local plan risk assessments. The local plans must include maps for the flood hazard. This typically involves an overlay of the Special Flood Hazard Area (SFHA) over the demographic data to determine what infrastructure and populations lie within the floodplain. The second requirement is for local risk assessments to include maps known high hazard areas. Chapter 6 of this plan discusses the steps VDEM goes through for review and approval of local plans and how the state coordinates with the local efforts.

Local Hazard Identification

The most significant hazards identified in the local hazard mitigation plans were flood, non-rotational wind, and winter weather, the same top three hazards that are identified in this revision of the statewide analysis. Local plans identified a variety of distinct hazards; Table 3.6-1 classifies these based on most localities that ranked the hazard as High, Medium-High, Medium, Medium-Low, Low, and Not Assessed. For example, flooding was given an overall ranking of high for comparison in this plan. Of the 20 plans, 18 plans ranked this as high and two as medium, resulting in an overall locality ranking of high. In addition to the hazard summarized in this report, local plans also assessed other hazards of local concern.

Table 3.6-1: Summary of local plan hazard ranking

High	Medium	Low	Not Assessed by Majority
Flood Non-rotational wind Winter	Tornado Drought Wildfire	Earthquake Geologic	Man-made Technological

Localities used a variety of approaches, ranging in complexity, to rank the hazards they identified as impacting their regions. Some plans used a blend of various techniques and discussions to arrive at their final ranking. Several of the major ranking/scoring techniques used in the local plans included:

- Quantitative scoring (based on available historical data, i.e. NCEI)
- Qualitative judgment/knowledge of locality
- Numerical scoring worksheets (based on criteria, i.e. FEMA 386-2 worksheets)
- Interactive activities with steering committee members

FEMA guidance indicates that the jurisdictions at greatest risk to specific hazards should be identified, considering both the characteristics of the hazard and the jurisdictions' degree of vulnerability. A variety of analysis methods may be sufficient to meet these goals; FEMA does not mandate a specific analysis method. As a result, many local and state plans have developed their own ranking system.

None of the ranking techniques used in the local plans are incorrect as there is no standard way to rank hazards that impact specific jurisdictions. Lack of available data for each hazard is often a driving factor in the ranking method's degree of subjectivity. The numerical rankings were frequently performed by different contractors, and different data processing methodologies were utilized. The variability in the ranking systems made it difficult to compare local hazard rankings to the state risk assessment.

Table 3.6-2 shows how each of the local plans ranked the hazards identified in their plans. Some modifications have been made to this table to be able to compare between localities and to the state plan. The local plans identified more than 70 hazards. Careful review determined that many of these hazards were not unique hazards; rather, they were simply variations in terminology. After review and refinement, these 70+ hazard terms were distilled to 10 hazard categories. This refinement allowed for comparison of the hazards and hazard rankings between the plans, and served to normalize the hazard data within the local plans for better applicability to this plan update.

In addition, not all jurisdictions used 'low, medium, and high' for their ranking terminology. Some allowed for hybrid rankings, such as 'medium-high'. To account for this, each ranking was assigned a number; in some cases, these numbers were

decimals. The rankings were numerically averaged, and then converted back to the standard terms of 'low, medium, and high.'

Table 3.6-2: Local Plan Hazard Ranking Summary

Plan name	Year	Flood	Drought	Earthquakes	Geologic	Winter Weather	Fish Kills	Non-rotational wind	Tornadoes	Wildfire	Man Made
Accomack-Northampton Planning District Commission	2012	High	Medium	Unranked	Unranked	Medium	Low	High	Low	Low	Low
Commonwealth Regional Plan	2016 Draft	Medium	High	Unranked	Low	High	Unranked	High	Medium	Medium	Unranked
Central Shenandoah Planning District Commission	2013	High	High	Low	Medium	High	Unranked	High	Medium	Medium	Low
Cumberland Plateau Planning District Commission	2013	High	Medium	Medium	High	High	Unranked	High	High	High	Unranked
George Washington Regional Commission	2017	High	Medium	Unranked	Low	High	Unranked	High	High	Medium	Unranked
Hampton Roads Planning District Commission	2017 (Draft)	High	Low	Low	Medium	Medium	Unranked	High	Medium	Low	Medium
LENOWISCO Planning District Commission	2013	High	High	Medium	High	High	Unranked	High	Medium	Medium	Unranked
Middle Peninsula Planning District Commission	2016	High	Low	Low	Low	Medium	Unranked	High	Medium	Low	Unranked
Mount Rogers Planning District Commission	2011	High	Medium	Low	Low	High	Unranked	Medium	Low	Medium	Unranked
New River Valley Planning District Commission	2011	High	Medium	Low	Low	High	Unranked	High	Low	Low	Medium
Northern Neck Regional Planning Commission	2011	Medium	Low	Unranked	Unranked	Medium	Unranked	High	Low	Low	Unranked
Northern Shenandoah Valley Regional Commission	2012	High	Low	Low	Unranked	High	Unranked	High	High	Medium	Medium
Northern Virginia	2017	High	Low	Medium	Low	High	Unranked	High	High	Low	Unranked
Rappahannock-Ripidan Regional Commission	2012	High	Medium	Unranked	Low	High	Unranked	High	Unranked	Medium	Unranked
Region 2000 Partnership	2013	High	High	Low	Low	High	Unranked	Medium	Medium	Medium	Low
Richmond-Crater Regional Planning Commission	2011	High	Medium	Low	Low	Medium	Unranked	Medium	Unranked	Low	Medium
Roanoke Valley-Alleghany Regional Commission	2013	High	Unranked	Low	Low	High	Unranked	Medium	Low	Medium	Unranked
Southside Planning District Commission	2013	High	High	Low	Low	High	Unranked	High	High	Medium	Unranked
Thomas Jefferson Planning District Commission	2012	High	Low	Low	Low	High	Unranked	Medium	Low	Low	Unranked
West Piedmont Planning District Commission	2016	High	Medium	Low	Low	High	Unranked	High	Medium	Medium	Unranked

Addressing Uncertainty in Hazard Identification

Future revisions of the local plans may help with some of the ambiguity between hazard naming conventions if VDEM outlines what applicable hazard names should be. VDEM will encourage local plan revisions to approach classifying hazards in a similar fashion as done in this revised risk assessment. Table 3.6-3 provides an outline of what types of events fall within the designated HIRA hazard categories. For this risk assessment the following hazards were evaluated: Flood, Wind, Tornado, Land Subsidence, Karst, Landslide, Winter Weather, Drought, Wildfire, and Earthquake. There were discussions on how to determine what belongs in the hazard category of wind. Hurricanes are one of the Commonwealth's most costly hazards; however, it is a combination of two hazards, wind and flood. Since the impacts of high wind, excluding tornado, are the same whether it be from a tropical system or a severe thunderstorm it was decided they should be grouped together in a non-rotational wind category.

Table 3.6-3: Summary of hazard events by HIRA category hazards

Flood	Non-Rotational Wind	Winter Weather	Tornado	Drought	Wildfire
Riverine	Wind	Snow	Tornado	Drought	Wildfire
Coastal	Thunderstorm	Ice		Extreme heat	Dense smoke
Tsunami	Hurricane	Extreme cold			
Erosion		Nor'easter			
Hurricane					
Nor'easter					
Sea level rise					

Earthquake	Land Subsidence (Karst)	Landslide	Impoundment Failure
Earthquake	Land subsidence	Landslide	Dam failure Levee failure
	Karst		

Assessment of Local Vulnerability and Potential Losses

Local hazard rankings are highly variable; as a result each one has its own set of criteria to develop monetary loss values and is not consistent across the 20 plans. This variability does not lend itself to being able to compare relative loss values for each hazard in the statewide plan. Annualized loss values were pulled out of the local plans and brought into this plan for comparison. Flood and hurricane wind were the two dominate hazards that had annualized loss values associated with them.

Table 3.6-4 illustrates the wide range in annualized loss estimates that have been pulled from the local plans. Some plans provided total loss estimates for a specific flood or hurricane event, but did not provide annualized losses. In these instances, N/A was listed in the table. Without proper documentation and data, these values cannot be compared in their current form. Some of the local plans used FEMA's HAZUS software for this analysis, while others may have used a combination of past event damages and years of record.

Table 3.6-4: Local Hazard Mitigation plan annualized loss estimates

PDC/Jurisdiction	Hurricane Wind Loss	Total Flood Loss
Accomack-Northampton	N/A	N/A
Central Shenandoah Valley	N/A	$3,681,938
Commonwealth Regional Council	$274,179*	$394,942*
Cumberland Plateau	N/A	N/A
George Washington	N/A	$148,793,000*
Lenowisco	N/A	N/A
Hampton Roads	$86,748,000*	N/A
Middle Peninsula	$1,657	$18,102,000*
Mount Rogers	N/A	N/A
New River Valley	$563,000*	$248,883*
Northern Neck	N/A	$6,625,524
Northern Shenandoah Valley	N/A	$6,857,556*
Northern Virginia	$5,398,000*	$1,061,851,000*
Rapahannock-Rapidan	$139,000*	$31,250,000*
Region 2000	N/A	$2,094,999*
Richmond and Crater	$6,515,038	$2,674,649
Roanoke Valley-Alleghany Region	N/A	N/A
Southside	$482,000*	N/A
Thomas Jefferson	$360,000*	$204,744
West Piedmont	$27,087,613*	$1,127,683
Total	**$127,568,487**	**$1,283,906,918**

** HAZUS estimates*

Data Collection

In previous revisions of this document, efforts to collect local hazard and critical facility data were made, but ultimately, in most cases, the local data was derived from the same sources that are currently being used for the state plan. In other cases local data was available but was so variable in content that it could not be merged for a statewide analysis. Thus, the extent of incorporation of local plans is limited to the summarization of their methods and results.

Future Revisions

Localities have completed or are working on revisions for the local hazard mitigation plans. Guidelines proposed in this revision will hopefully streamline local efforts and allow for accurate comparisons among jurisdictions based on future revisions of local hazard mitigation plans.

VDEM has provided, and will continue to provide, technical assistance to locals to develop their mitigation plans. VDEM in coordination with local jurisdictions, have

held and will continue to hold a series of planning workshops, technical reviews, and financial resources.

There are numerous statewide mitigation actions that can be adapted for local mitigation plans. Local governments updating their plans are urged to review these, as well as the individual hazard sections in this report, and contact VDEM for additional assistance.

Integration of the local plans into the statewide plan is an ongoing process as local plans are reviewed and standardization issues are addressed. See the *State and Critical Facility Analysis (*Section 3.4) of this chapter for more information on standardization of facility datasets.

Section 3.7 Communicable Disease

Description

A communicable disease is an illness caused by an infectious agent or its toxic products that develops when the agent or its product is transmitted from an infected person, animal or arthropod to a susceptible host. Infectious agents include viruses, bacteria, fungi, parasites, or aberrant proteins called prions. The infectious agent might spread by one of several mechanisms, including contact with the infected individual or his or her body fluids, contact with contaminated items or a vector, or contact with droplets or aerosols. An infection, which is the actual spread of the infectious agent or its toxic product, is not synonymous with disease because an infection may not lead to the development of clinical signs or symptoms.

The term infectious describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function[1].

The potential impact of communicable diseases is often recognized to be very high following any natural disaster. Communicable diseases associated with natural disasters include water-borne diseases such as diarrheal diseases, Hepatitis A and E, and vector-borne diseases as such West Nile Virus and Dengue. Increases in endemic diseases and the risk of outbreaks, however, are dependent upon many factors that must be systematically evaluated with a comprehensive risk assessment. This allows the prioritization of interventions to reduce the impact of communicable diseases post-disaster. Rapid detection of cases of epidemic-prone diseases is essential to ensure rapid control. The Virginia Department of Health has a surveillance/early warning system established that would quickly detect outbreaks and monitor priority epidemic diseases.

Zika virus, pandemic influenza, Ebola, Middle East Respiratory Syndrome (MERS), tuberculosis, hepatitis A, and pertussis (also known as whooping cough) are examples of communicable or infectious diseases that can affect humans. For domestic and farm animals in Virginia, there are also several communicable illnesses that could impact animal populations; examples include Eastern Equine Encephalitis (EEE), avian influenza, and rabies[2].

Historic Occurrence

The Commonwealth has a long and documented history of illness and disease. Pre-colonial Virginia was very familiar with illness and death. Typhoid fever and dysentery killed at least 30 percent of the residents of Jamestown, and lead to the abandonment of the town in 1624. Later settlers also fell victim to an array of communicable and infectious diseases, many caused by

famine or vitamin deficiencies, and others caused by pathogens previously unknown to Europeans. Historical records link thousands of early colonial deaths to dysentery, typhoid fever, and amebiasis caused by *Endamoeba histolytica*[3].

Table 3.7-1, based on available records from the Virginia Department of Health and the US Centers for Disease Control and Prevention, describes some of the recent occurrences of disease in Virginia's history.

Table 3.7-1: Recent Disease Occurrences in Virginia

Year	Description
2016	Prior to December 2015, there were no documented cases of Zika virus disease in Virginia. As of February 2017, there were 114 confirmed cases of Zika virus disease in Virginia. Half of these cases were in the Northern Health Planning Region; 17% were in the Northwest Region, 15% were in the Central Region, 10% were in the Southwest Region, and the remaining 9% were in the Eastern Region.[4]
2016	In 2016, the Virginia Department of Health investigated a statewide outbreak of hepatitis A caused by widespread distribution of a commercial food product that was contaminated with the hepatitis A virus (HAV). A total of 110 Virginia residents infected with HAV were linked to the outbreak, with illness onsets occurring from May to October 2016. Approximately 35% of patients were hospitalized and no deaths were reported. Adults were more commonly affected, with patients ranging in age from 14-70 years (median 36); only 20% of persons affected were 19 years or younger. The most commonly reported symptoms were nausea (90%), fatigue (89%), dark urine (84%), and anorexia (83%). The product that was contaminated was imported frozen strawberries, which were used in smoothies. Of patients who could recall the type of smoothie consumed (n=96), 100% reported drinking a smoothie containing frozen strawberries. FDA testing identified virus in the strawberries, which had been imported from Egypt.[5]
2015	In 2015, three EEE-infected horses were reported in the eastern region and one West Nile Virus (WNV) infected horse was reported in the northern region. Testing of sentinel chickens revealed 21 WNV-positive chickens in the Chesapeake, Norfolk, Suffolk, and Virginia Beach area, and 19 EEE-positive chickens in the Chesapeake, Norfolk, Suffolk, and Virginia Beach area.[6]
2014	35 sentinel chickens tested positive for EEE in the Hampton Roads area in 2013, down from 40 that tested positive in 2012. One horse in the central region was infected and euthanized.[7]
2013	*Cyclospora cayetanensis* is a parasite that causes an intestinal infection in humans called cyclosporiasis. In 2013, a total of 631 people in the US became ill, most in June and July of that year. Four cases were identified in Virginia. The outbreak was eventually traced to multiple sources and suppliers.[8]
2012	From April to June 2012, a multi-state outbreak of *E. coli* impacted 18 people in nine states, including Virginia. Most of the ill were in Louisiana, but one confirmed case occurred in Virginia. The outbreak suspected to be linked to contaminated commercial food, but no source was identified before the outbreak ended.[9]

The Virginia Department of Health (VDOH) tracks reportable diseases throughout the Commonwealth, and makes an array of data products available (as allowed by law) on those reports. Figure 3.7-1 provides data on the top communicable illnesses by county for 2015 (the most recent year for which data are available). Figure 3.7-1 provides the incidence rate for the top ten communicable diseases across the state for 2015 (the most recent year for which data are available)[10].

Figure 3.7-1: Top Communicable Diseases by Locality, 2015

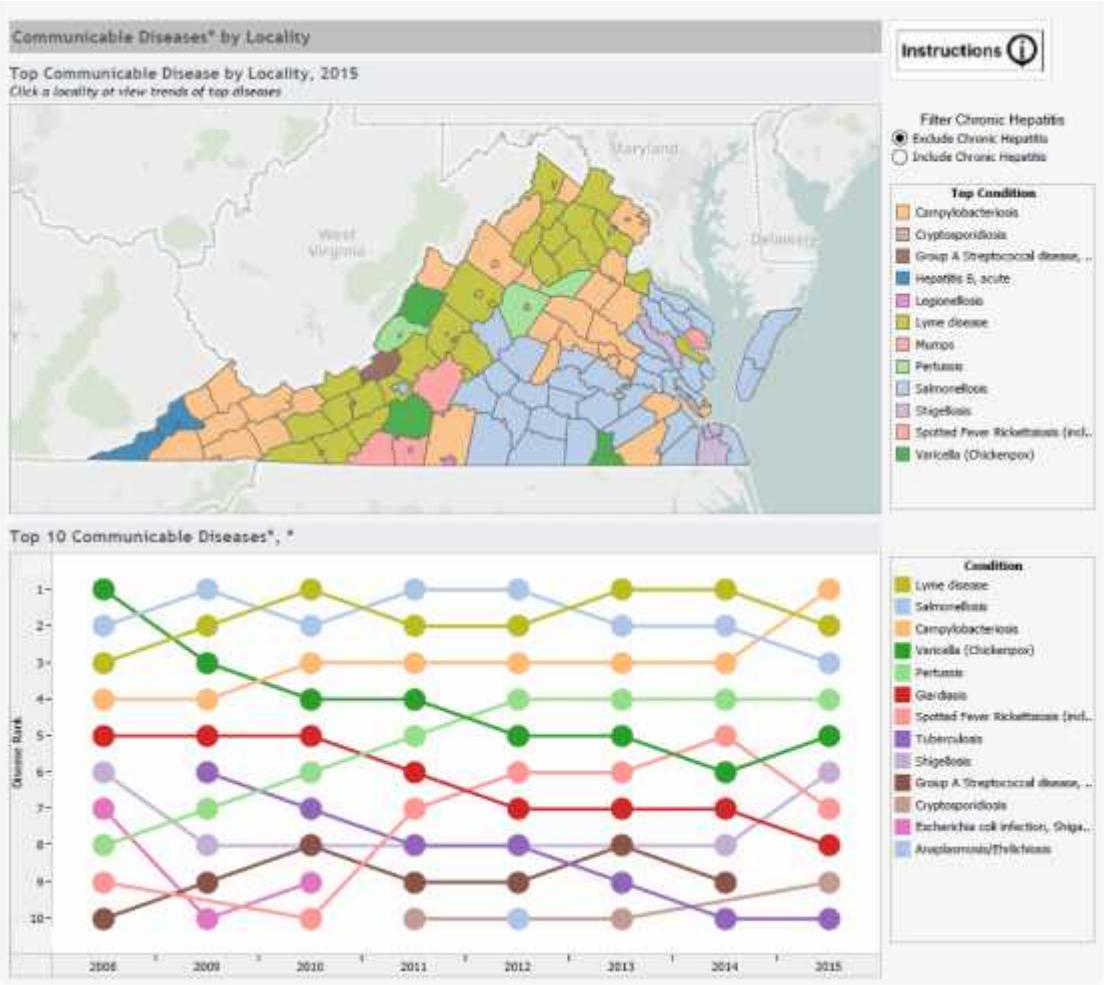
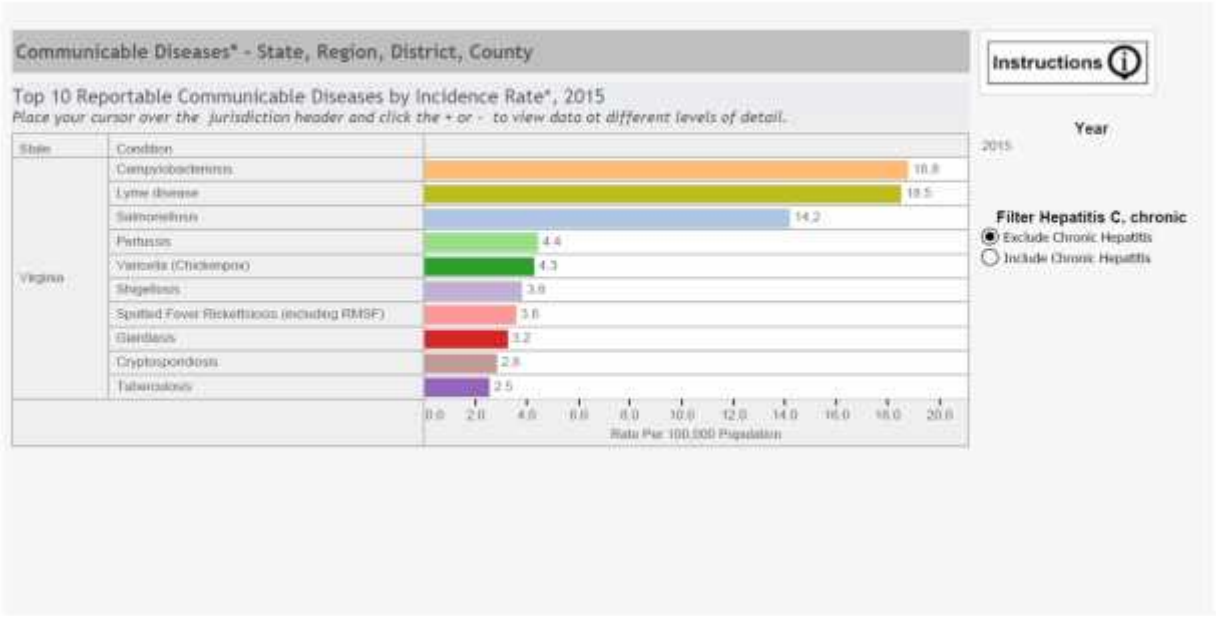


Figure 3.7-2: Top Communicable Diseases by Incidence Rate, 2015



Animal/Agricultural Concerns

Agriculture, including livestock, is the largest industry in the state, generating an economic impact of $52 billion annually. Many Virginia commodities and products rank in the top 15 among the states, including leaf tobacco (3rd), tomatoes (5th), apples (6th), grapes and peanuts (8th), and cotton (15th). Virginia ranks 6th in the nation for turkeys and 10th for broilers.[11]

Virginia has low-level outbreaks of vector-borne diseases regularly. Mosquito-borne illnesses, such as Eastern Equine Encephalitis (EEE) and West Nile Virus (WNV) occur regularly, and the state's surveillance, detection, and reporting systems are effective at containing cases before they spread.

In 1983 and 2002, outbreaks of low pathogenic avian influenza occurred in Virginia. As detailed in a 2006 report from the Virginia Department of Environmental Quality:

> In 1983 an avian influenza outbreak cost Virginia poultry farmers and industry $40 million, resulting in the disposal of 5,700 tons of poultry carcass material. Approximately 88% of the material was disposed of on site in burial trenches, and the remaining 655 tons of carcass were disposed of in a local sanitary landfill (McClaskey, 2004). The cost of on-site burial and landfill was $25 per ton or $142,000. Concerns about contaminated groundwater from these sites and the discovery, during the excavation of a school building site in the late 1990s, of relatively intact poultry carcasses buried for more than 15 years affected future decisions and responses.

> Eighteen years later the poultry industry in the central Shenandoah Valley was affected by an even larger avian influenza outbreak, costing the industry an estimated $130 million. At the time of the outbreak in 2002, more than 56 million commercial turkeys and chickens were being grown on over 1,000 poultry farms. On March 12, low pathogenic avian influenza was confirmed in a turkey breeder flock near Penn Laird, Virginia. One month later more than 60 flocks tested positive. A total of 197 farms were infected, and 4.7 million birds were destroyed to eradicate the virus. Turkeys accounted for 78% of the positive farms and bird losses.[12]

After the 2002 outbreak, the poultry industry in Virginia has been particularly vigilant in preventing another outbreak in the commonwealth. In addition, the Virginia Poultry Disease Task Force meets quarterly to review response plans for future outbreaks.[13] Because of these efforts, it has been 15 years since the last outbreak in Virginia.

Risk Assessment

Probability

The future incidence of communicable disease - either human or animal - is highly unpredictable and may be localized, which makes it difficult to assess the probability of a future occurrence. Unlike other hazards, near-term conditions cannot reliably be extrapolated from past trends. Infectious agents that can cause communicable diseases are constantly transmitted across Virginia, thus the real challenge is to assess the timing, location, and severity of the outbreak.

No sources of information on long-term historic frequency of communicable disease or future probability of communicable disease were identified for inclusion in this plan. As a result, while the future probability of some type of communicable disease outbreak may be estimated at 100%, the exact severity of future outbreaks cannot be quantified at this time.

Impact and Vulnerability

Virginia has extensive livestock operations throughout the state, many of which are subject to disease outbreaks. As of 2016, broilers accounted for $918 million in farm cash receipts in Virginia. Cattle/calves accounted for $714 million in farm cash receipts, and turkeys accounted for $326 million. Milk accounted for $478 million in cash receipts; all other animals (including horses, aquaculture, and other livestock) accounted for $216 million.[14] All told, livestock and animal products account for more than 11% of Virginia's $52 billion agriculture industry.

There are more than eight million people that reside in Virginia. Each one of them is at risk of exposure to a communicable disease. The Virginia Department of Health collects reports on certain categories of communicable disease, and publishes this information in annual reports. Table 3.7-2 provides a snapshot of this information, by the most populated jurisdictions in the state (as of the 2015 Census estimate).

Table 3.7-2: Selected Communicable Disease Cases Reported, by Most Populated Jurisdiction

Jurisdiction / Population	Illness	Cases reported – 2012	Cases reported – 2013	Cases reported – 2014	Cases reported – 2015	4-Year Average
Fairfax County 1,142,234	Hepatitis A	14	8	6	12	10
	Tuberculosis	92	59	58	66	69
	Pertussis	55	33	46	25	40
Virginia Beach 452,745	Hepatitis A	1	0	0	1	>1
	Tuberculosis	8	7	10	13	10
	Pertussis	34	40	19	7	25
Prince William County 451,721	Hepatitis A	3	4	4	1	3
	Tuberculosis	16	13	14	26	17
	Pertussis	34	15	25	8	201
Loudoun County 375,629	Hepatitis A	3	1	1	4	2
	Tuberculosis	15	7	10	10	11
	Pertussis	19	18	25	20	21
Chesterfield County 335,687	Hepatitis A	1	1	1	5	2
	Tuberculosis	5	5	0	3	3
	Pertussis	12	3	10	6	8

Short-term or contained outbreaks can be devastating for the people affected by them, but are unlikely to have significant, long-term impacts on the rest of the population or the state's economy. Long-term or uncontained outbreaks may have more impacts, as people may be unable to report to work for extended periods of time, either because they are sick or because they have been exposed to someone who is and are therefore quarantined. Tourism may also be impacted, as visitors are unwilling to travel to areas experiencing outbreaks.

Risk

The risk associated with communicable disease in Virginia has not been formally quantified, due to the difficulty in predicting specific occurrences, and the lack of complete data on impacts. There is almost no risk of property damage due to communicable disease in Virginia. Communicable disease can typically occur in every part of the state. Risk should be considered uniform across the Commonwealth.

As communicable disease is not a weather or geologic hazard, the NCEI does not have any historical records of events.

State Facility Risk

Risk associated with communicable disease has not been quantified in terms of geographic extent for this revision; thus, state facility risk has not been calculated. Generally, communicable disease related damages do not impact infrastructure.

Critical Facility Risk

Risk associated with communicable disease has not been quantified in terms of geographic extent; thus, critical facility risk has not been calculated. Generally, communicable disease related damages do not impact infrastructure.

Communicable Disease Risk to Energy Pipelines

Risk associated with communicable disease has not been quantified in terms of geographic extent; thus, energy pipelines risk has not been calculated. Generally, communicable disease related damages do not impact infrastructure.

Future Conditions Considerations

Weather and climate have significant effects on both human and animal help. With changes in climate, the frequency, severity, duration, and location of weather and climate phenomena, changes should be expected, such as rising temperatures, heavy rains, and droughts. Changes in weather and climate can affect health by changing the severity and/or frequency of health problems that are already in play, and by creating unanticipated or unforeseen health problems or threats that have not previously existed.

Many communicable diseases are transmitted by vectors, such as mosquitoes, ticks, and fleas. Vectors can transmit an array of pathogens, such as viruses, bacteria, and protozoa, that can cause illness in humans (or humans and animals). The seasonality and prevalence, as well as distribution patterns, of vector-borne illnesses are influenced by climate factors, such as temperature and humidity. It is anticipated that changes in climate may have both short-term and long-term effects on both vector-borne disease transmissions and infection patterns. This will affect seasonal risk and possibly lead to broad geographic changes in disease patterns over time. Because of the number of factors involved in predicting how changes in climate may impact communicable disease transmission, it is difficult to predict how, exactly, climate change will impact vector-borne illness transmission.

In addition, it is possible that changes in climate may allow or encourage the emergence of new or significantly altered illnesses, heretofore unknown to the medical community.[15]

Jurisdictional Risk

The hazard ranking for communicable disease is based primarily on the population count and population density for each jurisdiction. No geographic extent data was available for probability estimation; each jurisdiction was assigned a value of low (1) for ranking purposes. Property and crop damages were ranked as low for this hazard, as the hazard is unlikely to impact property and crops. Injuries and fatalities and events were estimated as medium (3) for all jurisdictions, to account for each jurisdiction's susceptibility to communicable disease. The parameters in the communicable disease risk assessment are described in Table 3.7-3, along with the total ranking.

Local Risk Assessment

Of the 20 local plans, no plan considered communicable disease in their hazard identification or risk assessment.

If future updates to the local plans determine that communicable disease should be included in the local plan, the Virginia Department of Health has a wealth of information that could be used to profile the hazard and assess the risk to the local area, including the State Epidemiology Response Plan and 35 local health districts.

Table 3.7-3: Communicable Hazard Ranking Parameters and Risk

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Ablemarle	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Alexandria, City of	Medium-High	High	Medium	Low	Low	Medium	Low	Medium
Alleghany	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Amelia	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Amherst	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Appomattox	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Arlington	High	High	Medium	Low	Low	Medium	Low	Medium
Augusta	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Bath	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Bedford	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Bland	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Botetourt	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Bristol, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Brunswick	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Buchanan	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Buckingham	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Buena Vista, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Campbell	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Caroline	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Carroll	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Charles City	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Charlotte	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Charlottesville, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Chesapeake, City of	High	Medium-High	Medium	Low	Low	Medium	Low	Medium
Chesterfield	High	Medium-High	Medium	Low	Low	Medium	Low	Medium
Clarke	Low	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Colonial Heights, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low
Covington, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Craig	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Culpeper	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Cumberland	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Danville, City of	Medium	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Dickensen	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Dinwiddie	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Emporia	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Essex	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Fairfax	High	High	Medium	Low	Low	Medium	Low	Medium
Fairfax, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low
Falls Church, City of	Low	High	Medium	Low	Low	Medium	Low	Medium-Low
Fauquier	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Floyd	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Fluvanna	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Franklin	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Franklin, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Frederick	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Fredericksburg, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low
Galax, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Giles	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Gloucester	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Goochland	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Grayson	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Greene	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Greensville	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Halifax	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Hampton, City of	Medium-High	High	Medium	Low	Low	Medium	Low	Medium
Hanover	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Harrisonburg, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low
Henrico	High	Medium-High	Medium	Low	Low	Medium	Low	Medium
Henry	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Highland	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Hopewell, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low
Isle of Wight	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
James City	Medium-High	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
King and Queen	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
King George	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
King William	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Lancaster	Low	Medium	Medium	Low	Low	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Lee	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Lexington, City of	Low	High	Medium	Low	Low	Medium	Low	Medium-Low
Loudoun	High	Medium-High	Medium	Low	Low	Medium	Low	Medium
Louisa	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Lunenburg	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Lynchburg, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Madison	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Manassas, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low
Manassas Park, City of	Low	High	Medium	Low	Low	Medium	Low	Medium-Low
Martinsville, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Mathews	Low	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Mecklenburg	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Middlesex	Low	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Montgomery	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Nelson	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
New Kent	Low	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Newport News, City of	High	High	Medium	Low	Low	Medium	Low	Medium
Norfolk, City of	High	High	Medium	Low	Low	Medium	Low	Medium
Northampton	Low	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Northumberland	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Norton	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Nottoway	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Orange	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Page	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Patrick	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Petersburg, City of	Medium	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Pittsylvania	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Poquoson	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Portsmouth, City of	Medium-High	High	Medium	Low	Low	Medium	Low	Medium
Powhatan	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Prince Edward	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Prince George	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Prince William	High	Medium-High	Medium	Low	Low	Medium	Low	Medium
Pulaski	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Radford, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Rappahannock	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Richmond	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Richmond, City of	High	High	Medium	Low	Low	Medium	Low	Medium
Roanoke	Medium-High	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Roanoke, City of	Medium-High	High	Medium	Low	Low	Medium	Low	Medium
Rockbridge	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Rockingham	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Russell	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Salem, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Scott	Medium	Low	Medium	Low	Low	Medium	Low	Medium-Low
Shenandoah	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Smyth	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Southampton	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Spotsylvania	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Stafford	Medium-High	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Staunton, City of	Medium	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Suffolk	Medium-High	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Surry	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Sussex	Low	Low	Medium	Low	Low	Medium	Low	Medium-Low
Tazewell	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Virginia Beach, City of	High	High	Medium	Low	Low	Medium	Low	Medium-Low
Warren	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Washington	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Waynesboro, City of	Medium	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Westmoreland	Low	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Williamsburg, City of	Low	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low
Winchester, City of	Medium	High	Medium	Low	Low	Medium	Low	Medium-Low
Wise	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
Wythe	Medium	Medium	Medium	Low	Low	Medium	Low	Medium-Low
York	Medium-High	Medium-High	Medium	Low	Low	Medium	Low	Medium-Low

For the 2018 plan update, the overall hazard ranking for communicable disease is medium-low.

Table 3.7-4: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Local emergency services can be severely impacted if a significant number of first responders for the area are compromised or unable to work.
Health and Safety of Response Personnel	Local emergency services can be severely impacted if a significant number of first responders for the area are compromised or unable to work. High probability of illness in affected population; potential exists for fatalities depending on severity and duration of illness; children and elderly immune suppressed most vulnerable.
Continuity of Operations	Continuity of Operations Plans may be activated if a significant number of staff or leadership is unable to report to work due to illness.
Property, Facilities, and Infrastructure	Limited or no impacts for the built environment.
Delivery of Services	Local services can be severely impacted if a significant number of staff for the area are compromised or unable to work.
The Environment	Limited or no impacts for the environment. Diseases that cause widespread deaths of animals, both captive and wild, or widespread deaths of human would have an effect on the environment in terms of disposal of the carcasses and disposal of human remains and the handling of bio-hazardous waste
Economic and Financial Condition	Local economy could face moderate impacts for the duration of the event, dependent on the number of people unable to work and businesses unable to open.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient.

Endnotes

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Section 3.8 Drought



Little Creek Reservoir Toano, Virginia
2007
Source: www.drought.gov

Description

Droughts are short-term or long-term water deficiencies that cause agricultural, environmental, and societal impacts. They can occur in any part of the state and can last for long periods of time. Agricultural drought is the most common, characterized by unusually dry conditions during the growing season, and can have significant economic effects on local agriculture. Meteorological drought is defined as an extended period (generally six months or more) when precipitation is less than 75 percent of normal during that period. Hydrologic drought is characterized by extremely low stream flow levels, and is caused by a prolonged meteorological drought.

All droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern anomaly lasts a short time – such as a few weeks or months – the drought is considered short-term. If the weather or atmospheric pattern becomes entrenched and the precipitation deficit lasts for several months or years, the drought is considered long-term. It is possible for a region to experience a long-term pattern that produces drought and to have short-term changes in this pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet pattern to be interrupted by short-term dry spells that result in short term droughts[i].

Current drought conditions in Virginia are tracked by the Drought Monitoring Task Force (DMTF), an interagency group made up of representatives from both state and federal agencies. The Task Force's status reports integrate information from various state and federal organizations to provide a complete picture of current and near-term drought conditions[ii].

Current drought conditions nationwide are tracked by the US Drought Monitor, a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, federal, and state environmental and climatologic organizations. The US Drought Monitor blends a variety of drought indicators to produce a weekly drought condition status map for the nation[iii].

Droughts are typically quantified based on indices that consider rainfall, temperature, stream flow, groundwater, and/or other factors. One of the most commonly-cited drought measures is the Palmer Drought Severity Index (PSDI), first documented in a 1965 paper by Wayne Palmer, uses temperature and precipitation information for a location in a formula to quantify dryness. A Palmer index value of zero indicates normal conditions, with increasingly negative values indicating increasing drought severity. PDSI is specifically intended to measure long-term droughts. Other drought indices, such as the crop moisture index (CMI) use different methods and formulas to quantify dryness, and may be more appropriate for specific applications, including measuring short-term droughts. The US Drought Monitor uses a variety of drought indices, including the Palmer index, to produce an overall drought severity classification.

Extreme Heat

A heat wave is defined as prolonged periods of excessive heat, often combined with excessive humidity. Extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. A heat wave combined with a drought is a dangerous situation[iv].

The main concern in periods of extreme heat is the potential public health impact, such as heat exhaustion or heat stroke. Individuals of concern include those living in residences without air-conditioning, or in areas where electric service is unavailable due to system-wide blackouts.

The jurisdictions included in the George Washington Regional Commission ranked extreme heat medium to medium-high. Richmond-Crater combined extreme heat with drought and ranked the hazard as moderate. Five other planning district commissions ranked extreme heat as low. Section 3.6 includes the overall rankings for the local plans. Due to the limited impacts to population and infrastructure, this hazard was not analyzed in detail as part of this plan.

Historic Occurrence

Table 3.8-1, based on available records from VDEM, local plans, and the National Weather Service (NWS), describes some of the major recorded droughts in Virginia's history.

Table 3.8-1: Selected Droughts in Virginia's History

Year	Description
1607	An extended drought threatens Jamestown; many did not survive. (from Thomas Jefferson PDC)
1930	The Virginia Piedmont counties of Loudoun, Fauquier, and Culpeper registered less than 21 inches of rain for the year – about half of the normal amount. From July through November of 1930, no rain gauge in the Piedmont registered more than 1.6 inches of rain[v].

Year	Description
1962-1971	The cumulative stream flow deficit is the largest because of its duration; however, it was not as severe as the 1930 drought.
1985-1988	Severe drought in the entire southeast US.
1993	Hot, dry weather affected 23 counties and was responsible for an estimated $75 million in crop damages.
1995	Suffolk City was declared a Drought Disaster Area, with an estimated $13.3 million in crop damages.
1997	Drought conditions resulted in crop damages estimated at $73.8 million in central, eastern, and northern Virginia.
1998	Drought conditions resulted in crop damages estimated at $66.5 million in the Eastern Piedmont and Northern Neck regions of Virginia.
1999	Drought conditions resulted in crop damages estimated at $83 million in Northern Virginia.
2000s	Throughout most of the early and mid-2000s the entire southeastern U.S. has been in varying levels of drought, including Virginia. In November 2002, 45 counties were approved for primary disaster designation by the US Secretary of Agriculture, while 36 requests were still pending. This dry period led to water conservation restrictions throughout the state and exacerbated water supply infrastructure problems, especially in rural communities.
October 2005	The Town of Big Stone Gap experienced a water shortage due to a combination of drought-like conditions and construction activities on a new dam for the Big Cherry Reservoir. A state of emergency was declared, and about $1.3 million in state funding was used to help offset the costs of local emergency water supply operations.
2007	Seventeen counties fell into severe drought status as over $10 million in crop damages occurred in southwest Virginia.
June 2007	In the Town of Goshen, a pump failure caused water pressure to drop, and many older pipes (circa 1930), which were already in fragile condition, cracked and caused major leaks. The water system was forced to shut down for repairs. A state of emergency was declared, and water was shipped in and distributed with assistance from the National Guard, volunteer organizations, and church groups.
2010	The summer of 2010 was hot and dry. Most of the state suffered from moderate to severe drought conditions, and some jurisdictions were placed under water restrictions.
2012-2013	La Nina conditions produced extreme and exceptional drought conditions throughout much of the US, Canada, and Mexico. Peak drought conditions in July resulted in more than 80% of the country with at least abnormally dry conditions. For this event, much of Virginia was classified as either abnormally dry or as experiencing moderate to severe drought conditions.

As of late 2016, precipitation totals have been below the watch indicator for many areas of the state. The DMTF issued a Drought Watch Advisory for the Northern Virginia and Northern Piedmont regions, which means that precipitation levels are low enough to warrant further monitoring of these areas for the development of drought conditions[vi].

Risk Assessment

Probability

The future incidence of drought is highly unpredictable and may be localized, which makes it difficult to assess the probability of drought. Near-term conditions can be extrapolated from past trends. Some form of drought affects Virginia every year, and so the real challenge is to assess the exact timing, location, and severity of drought conditions. Any assessment of historical or future drought conditions must also define the measures of drought to be tracked, a non-trivial task.

No sources of information on long-term historic frequency of drought or future probability of drought were identified for inclusion in this plan. This may be a result of many different definitions resulting in spotty reporting. As a result, while the future probability of some type of drought may be estimated at 100%, the exact severity of future drought cannot be quantified at this time.

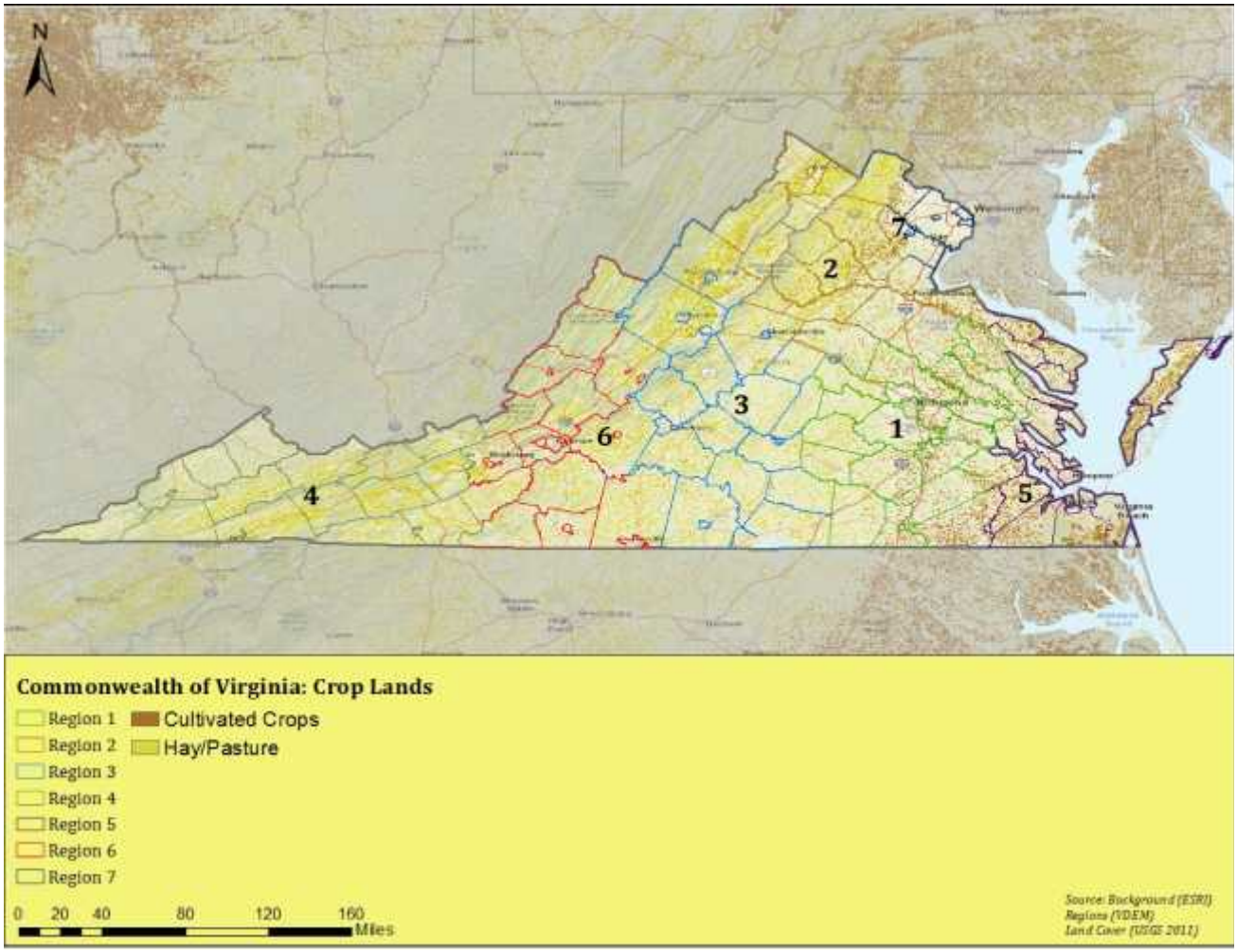
Impact and Vulnerability

Virginia has extensive agricultural operations throughout the state, many of which are vulnerable to shortages in rainfall. As of 2012, there were approximately 46,000 farms in the state, and approximately 33% of the state's land was held in farms (8,302,444 acres)[vii]. Because of the significant amount of cropland and agricultural operations in the state, drought is a hazard of concern. Precipitation at reliable, predictable times in the growing cycle of any crop is essential for the success of that crop, as every crop has a predictable growing season.

Evapotranspiration is a complex process with a variety of definitions and descriptions. Essentially, it is the evaporation of water from plant leaves. The rate of evaporation will vary widely depending on weather conditions (temperature, humidity, sunlight intensity, precipitation, wind, etc.). During dry periods – including droughts - transpiration can contribute to the loss of moisture in the soil, which can impact vegetation and crops[viii].

Figure 3.8-1 illustrates the distribution of cropland in Virginia. Cropland is defined by the 2012 Census of Agriculture as land from which crops were harvested and hay was cut, and land used to grow short-rotation woody crops, land in orchards, citrus groves, Christmas trees, vineyards, nurseries, and greenhouses[ix].

Figure 3.8-1: Cropland in Virginia



The top five counties with the greatest acreage of cropland are listed in Table 3.8-2.

Table 3.8-2: Acreage of Cropland by Jurisdiction for the Top Five Counties[x]

County	Cropland Acreage
Rockingham County	100,455
Pittsylvania County	100,408
Southampton County	94,267
Augusta County	89,558
Fauquier County	82,203

Short-term droughts occurring in sync with the growing season may have a significant impact on agricultural productivity, but may have little impact on public drinking water supply.

Long-term hydrologic drought can impact public water supplies, forcing local governments to enact water conservation restrictions. The cost of such restrictions has not been analyzed in this

plan, due to lack of data. Jurisdictions which have invested in water supply and distribution infrastructure are less vulnerable to drought.

In addition to the primary impacts of drought, there are also secondary impacts that can increase the potential for other hazards to occur. Extended periods of drought can increase the risk of wildfire occurrences. Wildfire occurrences can lead to an increase of burned woody debris that could increase the potential for landslides or mudflows.

Extreme Heat

Extreme heat conditions can be mitigated by air conditioning, which is generally widely available in modern life. Electrical grid strains are a concern during period of extreme heat, as the need for increased air conditioning (and thus electricity) can place strains on the grid. In extreme situations, these strains can lead to brown or blackouts, where the grid fails and no electricity (and therefore no air conditioning) is available to offset the effects of extreme heat. For those people who do not have ready access to air conditioned spaces, public areas – such as malls, libraries, or community centers – can be opened to the public, to ensure there is a place people can go to cool off.

People are vulnerable to the effects of extreme heat. The human body is designed to operate within a defined temperature range and with sufficient hydration. In the absence of sufficient hydration, dehydration can occur and become debilitating within a matter of hours. Similarly, exposure to temperatures above the normal range for an extended time – again, a matter of minutes or hours, depending on the age and health of the person – can result in serious injury or death. The very young, the elderly, and those with pre-existing health conditions are more likely to suffer impacts from extreme heat, as their bodies are generally less able to handle extreme heat conditions.

Extreme heat events can be exacerbated by power outages, resulting in the need for cooling shelters and other actions to reduce exposure to extreme heat. Virginia experienced this scenario in June 2012, following severe storms and a derecho. More than one million people were left without electricity – and therefore cooling – for up to a week. This was the third largest power outage in the Commonwealth's history. During this week, daytime temperatures were consistently above 90 degrees; cooling shelters has to be opened in locations throughout the outage area.

When extreme heat occurs, or is forecast to occur, the National Weather Service (NWS) local office issues heat advisories based on heat indices; these advisories are issued through the media and the Emergency Alert System. The NWS aids state and local health officials in preparing civil emergency messages for severe heat waves, in addition to preparing special weather statements that define who is most at risk, safety rules, and the expected severity of

the situation. The NWS also aids state and local authorities with issuing warnings and survival tips.

The NWS has defined criteria for these heat advisories, which are issues by the local office of the NWS. The following table defines these criteria[xi]. Note that these criteria are defined for the impact on people, and do not take any other factors into consideration, such as the effect of heat on operations, utilities, or any other governmental or commercial concern.

Table 3.8-3: Extreme Heat Advisory Criteria

Alert Issued	Criteria
Excessive Heat Warning	An Excessive Heat Warning is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Warning is when the maximum heat index temperature is expected to be 105°F or higher for at least two days and night time air temperatures will not drop below 75°F; however, these criteria vary across the country, especially for areas not used to extreme heat conditions. If you don't take precautions immediately when conditions are extreme, you become seriously ill or even die.
Excessive Heat Watch	Heat watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A Watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain.
Heat Advisory	A Heat Advisory is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Advisory is when the maximum heat index temperature is expected to be 100° or higher for at least two days, and night time air temperatures will not drop below 75°F; however, these criteria vary across the country, especially for areas that are not used to dangerous heat conditions. Take precautions to avoid heat illness. If you don't take precautions, you could become seriously ill or even die.
Excessive Heat Outlook	Excessive Heat Outlooks are issued when the potential exists for an excessive heat event in the next three to seven days. An Outlook provides information to those who need considerable lead-time to prepare for the event.

Risk

The risk associated with drought in Virginia has not been formally quantified, due to the difficulty in assessing the rate of incidence, and the lack of complete data on drought impacts. There is low risk of property damage due to drought in Virginia. Droughts can typically occur in every part of the state. Risk should be considered uniform across the Commonwealth.

Crop damages due to drought are uncertain, as agricultural productivity often varies with growing conditions from year to year. However, the NCEI *Storm Events Database* does report an annualized average of about $26.3 million of crop damages due to drought in the 20 years from 1996 and 2016. Other than crops, the NCEI database does not report any property damages due to drought.

State Facility Risk

Risk associated with drought has not been quantified in terms of geographic extent for this revision; as a result, state facility risk has not been calculated. The majority of drought related damages do not impact infrastructure.

Critical Facility Risk

Risk associated with drought has not been quantified in terms of geographic extent for this revision; as a result, critical facility risk has not been calculated. The majority of drought related damages do not impact infrastructure.

Drought Risk to Energy Pipelines

Severe drought conditions can cause soil to shift, which may cause brittle pipelines to break. Soils that are prone to changes in volume with changing moisture content are called expansive soils. The capacity of soil to shrink and sell is dictated by the clay minerals present in that soils, particularly montmorillonite, which can cause swelling of up to 15 times the dry volume and exert pressure of more than 30,000 pounds per square foot. Seasonal changes in soil moisture can increase the shrink/swell behavior of expansive soils. Expansive soils may be recognized by large cracks that form during droughts. The risks associated with expansive soils – including those posed to buried pipelines – may be exacerbated by prolonged drought followed by soil-saturating precipitation[xii].

Future Conditions Considerations

Information provided by the Governor's Climate Commission indicates that Virginia is "moving towards more widespread impacts under the driest conditions." While the data is not yet conclusive that chronic or increased drought conditions already have or will definitely evolve in Virginia, there is sufficient evidence to cause concern and to monitor future drought conditions. In addition to concerns regarding livestock, croplands, and people, the 808,000 acres of freshwater wetlands in Virginia are also at risk during prolonged drought conditions[xiii].

The 2012 *National Climate Assessment* describes increased temperatures and more frequent droughts as a result of climate change. Assuming a "business as usual" emissions scenario is maintained, NASA's Langely Research Center predicts that a nine degree increase in average temperatures in Virginia could be reality by 2100. This would mean that most of Virginia would be warmer than parts of Texas are currently. NASA has also confirmed that 2012 was the ninth

warmest year since 1880, and that – excepting 1988 – the nine hottest years have occurred since 2000, with 2010 and 2015 being the hottest. NASA stresses that the important consideration in these figures is that this is not a single or a handful of years that are warmer – this is decade after decade of increases in temperatures. The report confirmed that "heat and precipitation extremes will be five times more likely by 2100 in Virginia, with a once-in-20-year-event occurring every four years"[xiv].

Based on information provided by the US EPA and in consideration of climate assessments from the US Global Change Research Program, the Intergovernmental Panel on Climate Change, and the EPA's *Climate Change Indicators in the US,* changes in the drought pattern in Virginia will pose both positive and negative impacts on farming, agriculture, and people. Higher temperatures generally reduce productivity in livestock, and can lead to reduced yields of crops, including corn. But higher concentrations of atmospheric carbon dioxide can increase crop yields, which may offset the harmful effects of high temperatures on cotton, soybeans, wheat, and peanuts. These potentially higher yields, however, are reliant on the availability of water for irrigation. Rising temperatures will be also increase both the need for irrigation and the amount of water needed. If sufficient water for irrigation is not available, severe or prolonged droughts will result in reduced crop yields[xv].

Jurisdictional Risk

The hazard ranking for drought is based on parameters reported in the NCEI *Storm Events Database*. No geographic extent data was available for drought probability estimation; each jurisdiction was assigned a value of low (1) for ranking purposes. Annualized injuries, deaths, and property damages were also given a low ranking for the state because of the limited events in the NCEI storm events database. The parameters in the drought risk assessment are described in Table 3.8-4, along with the total ranking. The reporting of drought occurrence, and of drought-related crop damages, is shown to be generally higher in Northern, South-Central, and Southwestern parts of the state.

Of the local plans, 19 of 20 considered drought. (Only the Roanoke Valley-Alleghany Regional Commission Plan did not consider it.)

Local Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

19 of the 20 local plans provided a risk rank for drought or combination of drought and extreme heat. Most of these plans provided a general description of drought and its impact on their

region. Four plans used Census data to report the percentage of people on public and private wells. In addition, two plans included past regional water supply problems and complaints. A few local plans also discussed the types of crops and farmland in their regions. Four local plans provided annualized loss values based on the NCEI storm events database; this is the same data that was used for the statewide analysis. Two plans considered the NCEI data and annualized loss estimates, with results that showed negligible amounts of annualized losses. Table 3.8-4 shows the annualized loss values from the local plans. Local plans discussed the inability to calculate loss due to the lack of detailed record keeping of historical events, probability, and drought not having a physical impact on structures in terms of damage to structures.

Table 3.8-4: Local plan drought annualized loss

PDC/Jurisdiction	Local Plan Annualized Loss
Commonwealth RC	$1,193,181
Richmond-Crater	$2,739,683
Rappahannock-Rapidan	$2,046,333
Northern Virginia RC	$462,886
Hampton Roads	*Negligible (> $1,000)*
West Piedmont	*Negligible (> $1,000)*

Comparison with Local Ranking

Five of the 20 local plans ranked drought as a high hazard, eight ranked as medium, six ranked as low, and one did not give a ranking for drought. The local plan ranking average was medium for drought (section 3.6). The 2017 statewide analysis has ranked drought as medium risk. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases overall development patterns were discussed in general. In some cases, agricultural vulnerability was discussed as a part of the overall development trends section. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). Most the damages due to drought are not related to infrastructure. Communities with large amounts of agricultural land have some water supply related mitigation action items.

Table 3.8-5: Drought Hazard Ranking Parameters and Risk

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Low	High	Medium	Low	Medium-Low
Ablemarle	Medium-High	Medium	Low	Low	High	Medium-High	Low	Medium
Alexandria, City of	Medium-High	High	Low	Low	Low	Medium-High	Low	Medium-Low
Alleghany	Low	Low	Low	Low	Low	Medium	Low	Low
Amelia	Low	Low	Low	Low	Medium-High	Medium	Low	Medium-Low
Amherst	Medium	Medium	Low	Low	Low	Medium	Low	Medium-Low
Appomattox	Low	Low	Low	Low	Low	Medium	Low	Low
Arlington	High	High	Low	Low	Low	Medium-High	Low	Medium
Augusta	Medium-High	Medium	Low	Low	High	Medium-High	Low	Medium
Bath	Low	Low	Low	Low	Low	Medium	Low	Low
Bedford	Medium-High	Medium	Low	Low	Low	Medium	Low	Medium-Low
Bland	Low	Low	Low	Low	High	Medium	Low	Medium-Low
Botetourt	Medium	Medium	Low	Low	Low	Medium	Low	Medium-Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Brunswick	Medium	Low	Low	Low	Medium-High	Medium	Low	Medium-Low
Buchanan	Medium	Low	Low	Low	Low	Medium-High	Low	Medium-Low
Buckingham	Low	Low	Low	Low	Low	Medium	Low	Low
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Medium	Low	Medium-Low
Campbell	Medium	Medium	Low	Low	High	Medium	Low	Medium
Caroline	Medium	Low	Low	Low	Medium-High	Medium	Low	Medium-Low
Carroll	Medium	Medium	Low	Low	High	Medium-High	Low	Medium
Charles City	Low	Low	Low	Low	Medium-High	Medium	Low	Medium-Low
Charlotte	Low	Low	Low	Low	High	Medium	Low	Medium-Low
Charlottesville, City of	Medium	High	Low	Low	High	Medium-High	Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Chesapeake, City of	High	Medium-High	Low	Low	Low	Medium	Low	Medium-Low
Chesterfield	High	Medium-High	Low	Low	Low	Medium	Low	Medium-Low
Clarke	Low	Medium	Low	Low	High	Medium-High	Low	Medium-Low
Colonial Heights, City of	Medium	High	Low	Low	Low	Medium	Low	Medium-Low
Covington, City of	Low	Medium-High	Low	Low	Low	Medium	Low	Medium-Low
Craig	Low	Low	Low	Low	Low	Medium	Low	Low
Culpeper	Medium	Medium	Low	Low	Medium-High	Medium-High	Low	Medium
Cumberland	Low	Low	Low	Low	High	Medium	Low	Medium-Low
Danville, City of	Medium	Medium-High	Low	Low	High	Medium	Low	Medium
Dickenson	Low	Low	Low	Low	Low	Medium-High	Low	Low
Dinwiddie	Medium	Low	Low	Low	High	Medium	Low	Medium-Low
Emporia	Low	Medium-High	Low	Low	Low	Medium	Low	Medium-Low
Essex	Low	Low	Low	Low	Medium-High	Medium	Low	Medium-Low
Fairfax	High	High	Low	Low	Low	Medium-High	Low	Medium
Fairfax, City of	Medium	High	Low	Low	Low	Medium-High	Low	Medium
Falls Church, City of	Low	High	Low	Low	Low	Medium-High	Low	Medium-Low
Fauquier	Medium-High	Medium	Low	Low	Low	Medium-High	Low	Medium-Low
Floyd	Low	Low	Low	Low	High	Medium	Low	Medium-Low
Fluvanna	Medium	Medium	Low	Low	Medium	Medium	Low	Medium-Low
Franklin	Medium	Medium	Low	Low	High	Medium	Low	Medium
Franklin, City of	Low	Medium-High	Low	Low	Low	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Frederick	Medium-High	Medium	Low	Low	Medium	Medium-High	Low	Medium
Fredericksburg, City of	Medium	High	Low	Low	Low	Medium-High	Low	Medium-Low
Galax, City of	Low	Medium-High	Low	Low	High	Medium-High	Low	Medium
Giles	Low	Low	Low	Low	Low	Medium	Low	Low
Gloucester	Medium	Medium	Low	Low	Low	Medium	Low	Medium-Low
Goochland	Medium	Medium	Low	Low	Medium	Medium	Low	Medium-Low
Grayson	Low	Low	Low	Low	High	Medium-High	Low	Medium-Low
Greene	Medium	Medium	Low	Low	Medium	Medium-High	Low	Medium-Low
Greensville	Low	Low	Low	Low	Low	Medium	Low	Medium-Low
Halifax	Medium	Low	Low	Low	High	Medium	Low	Medium-Low
Hampton, City of	Medium-High	High	Low	Low	Low	Medium	Low	Medium-Low
Hanover	Medium-High	Medium	Low	Low	High	Medium	Low	Medium
Harrisonburg, City of	Medium	High	Low	Low	High	Medium-High	Low	Medium
Henrico	High	Medium-High	Low	Low	Medium	Medium	Low	Medium
Henry	Medium	Medium	Low	Low	High	Medium	Low	Medium
Highland	Low	Low	Low	Low	Low	Low	Low	Low
Hopewell, City of	Medium	High	Low	Low	Medium	Medium	Low	Medium
Isle of Wight	Medium	Medium	Low	Low	Medium-High	Medium	Low	Medium-Low
James City	Medium-High	Medium-High	Low	Low	Medium	Medium	Low	Medium-Low
King and Queen	Low	Low	Low	Low	High	Medium	Low	Medium-Low
King George	Medium	Medium	Low	Low	Medium	Medium-High	Low	Medium-Low
King William	Low	Low	Low	Low	Medium-High	Medium	Low	Medium-Low
Lancaster	Low	Medium	Low	Low	Medium-High	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Lee	Medium	Low	Low	Low	Low	Low	Low	Low
Lexington, City of	Low	High	Low	Low	Low	Medium	Low	Medium-Low
Loudoun	High	Medium-High	Low	Low	High	Medium-High	Low	Medium
Louisa	Medium	Medium	Low	Low	Medium-High	Medium	Low	Medium-Low
Lunenburg	Low	Low	Low	Low	Low	Medium	Low	Low
Lynchburg, City of	Low	Medium-High	Low	Low	High	Medium	Low	Medium-Low
Madison	Low	Low	Low	Low	Medium-High	Medium-High	Low	Medium-Low
Manassas, City of	Medium	High	Low	Low	Low	Medium-High	Low	Medium-Low
Manassas Park, City of	Low	High	Low	Low	Low	Medium-high	Low	Medium-Low
Martinsville, City of	Low	Medium-High	Low	Low	High	Medium	Low	Medium-Low
Mathews	Low	Medium	Low	Low	Low	Medium	Low	Medium-Low
Mecklenburg	Medium	Low	Low	Low	Low	Medium	Low	Medium-Low
Middlesex	Low	Medium	Low	Low	Medium	Medium	Low	Medium-Low
Montgomery	Medium-High	Medium	Low	Low	High	Medium	Low	Medium
Nelson	Low	Low	Low	Low	Medium	Medium-High	Low	Medium-Low
New Kent	Low	Medium	Low	Low	Medium	Medium	Low	Medium-Low
Newport News, City of	High	High	Low	Low	Low	Medium	Low	Medium
Norfolk, City of	High	High	Low	Low	Low	Medium	Low	Medium
Northampton	Low	Medium	Low	Low	High	Medium	Low	Medium-Low
Northumberland	Low	Low	Low	Low	Medium-High	Medium	Low	Medium-Low
Norton	Low	Medium-High	Low	Low	Low	Low	Low	Low
Nottoway	Low	Low	Low	Low	Medium-High	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Orange	Medium	Medium	Low	Low	High	Medium-High	Low	Medium
Page	Medium	Medium	Low	Low	High	Medium-High	Low	Medium
Patrick	Medium	Low	Low	Low	High	Medium	Low	Medium-Low
Petersburg, City of	Medium	Medium-High	Low	Low	Medium	Medium	Low	Medium-Low
Pittsylvania	Medium-High	Medium	Low	Low	High	Medium	Low	Medium
Poquoson	Low	Medium-High	Low	Low	Low	Medium	Low	Medium-Low
Portsmouth, City of	Medium-High	High	Low	Low	Low	Medium	Low	Medium-Low
Powhatan	Medium	Medium	Low	Low	High	Medium	Low	Medium-Low
Prince Edward	Medium	Medium	Low	Low	High	Medium	Low	Medium-Low
Prince George	Medium	Medium	Low	Low	Medium	Medium	Low	Medium-Low
Prince William	High	Medium-High	Low	Low	Low	Medium-High	Low	Medium
Pulaski	Medium	Medium	Low	Low	High	Medium	Low	Medium
Radford, City of	Low	Medium-High	Low	Low	High	Medium	Low	Medium-Low
Rappahannock	Low	Low	Low	Low	Medium-High	Medium-High	Low	Medium-Low
Richmond	Low	Low	Low	Low	Medium	Medium	Low	Medium-Low
Richmond, City of	High	High	Low	Low	Medium	Medium	Low	Medium
Roanoke	Medium-High	Medium-High	Low	Low	Low	Medium	Low	Medium-Low
Roanoke, City of	Medium-High	High	Low	Low	Low	Medium	Low	Medium-Low
Rockbridge	Medium	Low	Low	Low	Low	Medium	Low	Medium-Low
Rockingham	Medium-High	Medium	Low	Low	High	Medium-High	Low	Medium
Russell	Medium	Low	Low	Low	Low	Low	Low	Low
Salem, City of	Medium	High	Low	Low	Low	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Scott	Medium	Low	Low	Low	Low	Low	Low	Low
Shenandoah	Medium	Medium	Low	Low	High	Medium-High	Low	Medium
Smyth	Medium	Medium	Low	Low	High	Medium-High	Low	Medium
Southampton	Low	Low	Low	Low	Low	Medium	Low	Low
Spotsylvania	Medium-High	Medium	Low	Low	Low	Medium-High	Low	Medium-Low
Stafford	Medium-High	Medium-High	Low	Low	Medium	Medium-High	Low	Medium
Staunton, City of	Medium	Medium-High	Low	Low	High	Medium-High	Low	Medium
Suffolk	Medium-High	Medium	Low	Low	Low	Medium	Low	Medium-Low
Surry	Low	Low	Low	Low	Low	Medium	Low	Low
Sussex	Low	Low	Low	Low	Low	Medium	Low	Low
Tazewell	Medium	Medium	Low	Low	High	Medium	Low	Medium
Virginia Beach, City of	High	High	Low	Low	Low	Medium	Low	Medium
Warren	Medium	Medium	Low	Low	Medium-High	Medium-High	Low	Medium
Washington	Medium	Medium	Low	Low	Low	Low	Low	Medium-Low
Waynesboro, City of	Medium	Medium-High	Low	Low	High	Medium-High	Low	Medium
Westmoreland	Low	Medium	Low	Low	Medium-High	Medium	Low	Medium-Low
Williamsburg, City of	Low	Medium-High	Low	Low	Medium	Medium	Low	Medium-Low
Winchester, City of	Medium	High	Low	Low	Medium	Medium-High	Low	Medium
Wise	Medium	Medium	Low	Low	Low	Low	Low	Medium-Low
Wythe	Medium	Medium	Low	Low	High	Medium	Low	Medium-Low
York	Medium-High	Medium-High	Low	Low	Low	Medium	Low	Medium-Low

For the 2018 plan update, the overall hazard ranking for drought is medium low.

Table 3.8-6: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Local water supply distributions can be severely impacted if primary source of water for the area is compromised.
Health and Safety of Response Personnel	Limited impacts for response personnel unless water supply is compromised.
Continuity of Operations	Unlikely to execute Continuity of Operations Plan.
Property, Facilities, and Infrastructure	Localized areas may experience moderate impacts from downed water utilities, property and infrastructure damages are expected to be minimal.
Delivery of Services	The ability to supply water to needed areas can be impacted if the water supply is low, or the utility line is damaged.
The Environment	Droughts can result in a lack of water, causing animals to relocate to possibly more populated areas. Drought can also increase the vulnerability to wildfire, and flooding if persistent heavy rains occur.
Economic and Financial Condition	Local economy could face moderate impacts for the duration of the drought, dependent on the abundance of a local water supply.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient.

Endnotes

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Section 3.09: Earthquake



Louisa County
August 2011
Source: EPA Michael Reynolds

Description

According to the Virginia Division of Geology and Mineral Resources (VDGMR), plate tectonics theory states that the Earth's crust is composed of a dozen or more rigid plates that slowly bump against one another. Most earthquakes are the result of strain release along zones of weakness (faults) in response to the slow motion of those crustal plates.

Virginia is located near the center of the North American plate, far from a plate boundary. As a result, Virginia experiences a much lower rate of seismicity than areas near a plate boundary, such as California. Earthquake activity that occurs within a tectonic plate is a known as 'intraplate seismicity.' While these quakes occur with less frequency than plate boundary quakes, the impacts from them can still be extensive and severe.

Earthquakes in Virginia typically occur on faults at a depth of three to 15 miles. Thus, the earthquakes felt in the Commonwealth generally have no relationship with faults seen at the surface[1].

Earthquakes are the results of forces deep within the Earth's interior that continuously affect the surface of the Earth. The energy from these forces is stored in a variety of ways within the rocks. When this energy is suddenly released, for example by shearing movements along faults in the crust of the Earth, an earthquake results. The area of the fault where the sudden rupture takes place is called the focus or hypocenter of the earthquake. The point on the Earth's surface directly above the focus is called the epicenter of the earthquake[2].

The severity of an earthquake can be expressed in terms of both intensity and magnitude. However, the two terms are quite different, and they are often confused. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region, depending on the location of the observer with respect to the earthquake epicenter. Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments, which have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value.

Earthquake severity is commonly measured using different scales, the Modified-Mercalli Intensity scale and by the Richter Magnitude scale. Table 3.09-1 provides ranking and classification definitions for the two scales.

Table 3.09-1: Comparison of Earthquake Intensity Measurement Scales[3]

Richter Magnitude Scale	Modified Mercalli Intensity Scale
1.0 to 3.0	I
3.0 to 3.9	II to III
4.0 to 4.9	IV to V
5.0 to 5.9	VI to VII
6.0 to 6.9	VII to IX
7.0 and Higher	VIII or Higher
Defined Modified Mercalli Intensity Scale Rating	
I	Not Felt except by a very few under especially favorable conditions
II	Felt only by a few persons at rest, especially on upper floors of buildings
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors, disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Historic Occurrence

To date, there has been one federal disaster declaration for an earthquake in the Commonwealth (See Section 3.3).

Historical earthquake occurrences (Table 3.09-2) are based on available records from the Virginia Tech Seismological Observatory (VTSO) and the Virginia Division of Geology and Mineral Resources (DGMR). This table was updated as part of this plan update; no major earthquakes were found to have occurred in Virginia since 2011.

Table 3.09-2: Major Earthquakes in Virginia (1774-2016)[4]

Year	Month	Magnitude (Richter Scale)	Epicenter Location	Description
1774	21-Feb	4.5	Petersburg City Prince George County	A sharp earthquake that was felt over much of Virginia displaced houses "considerably off their foundations" at Blandford and Petersburg. Although the shock was severe at Richmond and terrified residents about 80 km north of Richmond at Fredericksburg, it caused no damage at those towns. Several "smart shocks" were reported in parts of Virginia from Feb. 20th to the 22nd. The main tremor rang bells at Salem (now Winston-Salem), N.C.
1833	27-Aug	4.5	Central Virginia Goochland County	A rather strong shock agitated walls of buildings at Lynchburg (west of Richmond, in southern Amherst County) and rattled windows violently. Fences along the road were shaken near the Louisa County Courthouse, northwest of Richmond. It was described as "severe" at Charlottesville, about 85 km northeast of Lynchburg. Two miners were killed in a panic caused by the tremor at a mine near Richmond.
1852	29-Apr	4.8	Town of Wytheville Wythe County	A severe earthquake that was observed over a large area threw down a chimney near Wytheville, in southwest Virginia, and shook down tops of chimneys at Buckingham Courthouse, about 55 km south of Charlottesville. Houses were shaken violently at Staunton, about 65 km west of Charlottesville. A brick was shaken from a chimney as far south as Davie County, N.C. Also felt in the District of Columbia, Maryland, New York, Ohio, and Pennsylvania.
1852	2-Nov	4.3	Central Virginia Buckingham County	Chimney damage occurred at Buckingham, about 55 km south of Charlottesville. This earthquake was reported to be "quite strong" at Fredericksburg, Richmond, and Scottsville. At Scottsville, where every house in the village was shaken, water in the canal was "troubled," and boats were tossed to and fro.

Year	Month	Magnitude (Richter Scale)	Epicenter Location	Description
1875	23-Dec	4.8	Central Virginia Goochland County	The highest intensities from this earthquake occurred mainly at towns near the James River waterfront in Goochland and Powhatan Counties, and in Louisa County. In Richmond (Henrico County), the most severe damage was sustained in the downtown business and residential areas adjacent to the James River or on islands in the river. Damage included bricks knocked from chimneys, fallen plaster, an overturned stove, and several broken windows. Waves "suddenly rose several feet" at the James River dock at Richmond, causing boats to "part their cables" and drift below the wharf. At Manakin, about 20 km west of Richmond, shingles were shaken from a roof and many lamps and chimneys were broken. Several small aftershocks were reported through Jan. 2, 1876. Felt from Baltimore, Md., to Greensboro, N.C., and from the Atlantic Coast westward to Greenbrier and White Sulphur Springs, W.Va.
1897	3-May	4.3	Southwest Virginia Pulaski County	This earthquake was most severe at Radford (about 65 km west of Roanoke), where a few chimneys were wrecked and plaster fell from walls. Chimneys were damaged at nearby Pulaski and at Roanoke. Felt in most of southwest Virginia and as far south as Winston-Salem, N.C.
1897	31-May	5.8	Town of Pearisburg Giles County	This earthquake was the largest in intensity and areal extent in Virginia in historical times and is the 3rd largest in the eastern US and was felt in 12 states. The earthquake had a maximum Modified Mercalli Intensity of VIII, and the area of maximum ground motion extended over an elliptical area-from near Lynchburg, Va., west to Bluefield, W.Va., and from Giles County south to Bristol, Tenn. The MM intensity VIII assigned to this earthquake is based on "many downed chimneys" and "changes in the flow of springs." The shock was strong at Pearisburg, where walls of old brick houses were cracked and many chimneys were thrown down or badly damaged. Many chimneys also were shaken down at Bedford, Pulaski, Radford, and Roanoke, Va., and Bristol, Tenn.; many chimneys were damaged at Christiansburg, Dublin, Floyd, Houston, Lexington, Lynchburg, Rocky Mount, Salem, Tazewell, and Wytheville, Va.; Charlotte, Oxford, Raleigh, and Winston, N.C.; Knoxville, Tenn.; and Bluefield, W.Va. Felt from Georgia to Pennsylvania and from the Atlantic Coast westward to Indiana and Kentucky. Aftershocks continued through June 6, 1897 (see Figure 3.13-4).

Year	Month	Magnitude (Richter Scale)	Epicenter Location	Description
1898	5-Feb	4.4	Pulaski County	Bricks were thrown from chimneys, furniture was shifted in a few houses, and residents rushed into the streets at Pulaski, about 70 km southwest of Roanoke. Felt throughout southwest Virginia and south to Raleigh, N.C.
1907	11-Feb	4	Town of Arvonia Buckingham County	Chimneys were cracked at Ashby, about 20 km southeast of Arvonia, and a window was broken at a store at Buckingham, 25 km southwest of Arvonia. A "terrific" shock sent people rushing outdoors at Arvonia and displaced furniture. Felt strongly from Powhatan to Albemarle County.
1918	10-Apr	4.6	Town of Luray Page County	In the Shenandoah Valley, at Luray, windows were broken and plaster was cracked severely. Ceilings of houses were cracked badly a few kilometers north of Luray, at Edinburg; windows were broken at Harrisonburg and Staunton, Va., and Washington, D.C. (at Georgetown University). In addition, a new spring formed in Page County, near Hamburg, almost in the middle of a road. A minor aftershock was reported in the area about 5 hours later. Also felt in Maryland, Pennsylvania, and West Virginia.
1919	6-Sep	Unknown	Town of Front Royal Warren County	This earthquake affected towns mainly in Warren and Rappahannock Counties. At Arco, in the Blue Ridge Mountains south of Front Royal, chimneys were damaged, plaster fell from walls, and springs and streams were muddied. Reports from the adjacent northern part of Rappahannock County state that similar shocks were felt and that streams were "rendered turbid." Also felt in parts of Maryland and West Virginia. Several aftershocks occurred.
1929	26-Dec	3.7	Charlottesville City Albemarle County	A moderate tremor at Charlottesville shook bricks from chimneys in some places; also felt in other parts of Albemarle County.
1959	23-Apr	3.9	Giles County	The earthquake was strongest in Giles County, at Eggleston and Pembroke. Residents there reported several damaged chimneys and articles shaken from shelves and walls. One chimney toppled at the Norfolk and Western Station in Eggleston. Also felt in West Virginia.
1975	11-Nov	3.2	Southwest Virginia Giles County	Windows were broken in the Blacksburg area of Montgomery County, and plaster was cracked at Poplar Hill (south of Pearisburg, in Giles County). Also felt in Pulaski County.

Year	Month	Magnitude (Richter Scale)	Epicenter Location	Description
1976	13-Sep	3.3	Southwest Virginia Carroll County	Bricks fell from chimneys and pictures fell from walls in Surry County at Mount Airy, N.C. At the nearby town of Toast, N.C., cracks formed in masonry and plaster. The earthquake was observed in many towns in North Carolina and Virginia and in a few towns in South Carolina and West Virginia.
2003	9-Dec	4.5	Central Virginia Powhatan County *(picture on page 1)*	This was a complex event consisting of two sub-events occurring 12 seconds apart. Felt (V) at Columbia, Fork Union, Goochland, Oilville, Rockville and Sandy Hook; (IV) at Appomattox, Amelia Court House, Amherst, Blackstone, Bumpass, Charlottesville, Chester, Chesterfield, Colonial Heights, Cumberland, Dillwyn, Farmville, Glen Allen, Lawrenceville, Louisa, Manakin Sabot, Mechanicsville, Midlothian, Mineral, Palmyra, Petersburg, Powhatan, Richmond, Scottsville and Spotsylvania; (III) at Alexandria, Fairfax, Falls Church, Fredericksburg, Lexington, Lynchburg, McLean, Roanoke, Staunton and Vienna. Felt in much of Maryland and Virginia. Also felt in north-central North Carolina and a few areas of Delaware, New Jersey, New York, Pennsylvania, and West Virginia.
2008	18-Apr	5.2	Wasbash Valley, Illinois	An earthquake occurred in the Wabash Valley Seismic Zone in southeastern Illinois. A series of aftershocks, including one with an estimated moment magnitude of 4.6, follow the main shock.
2008	6-May	2.0	Annandale	A minor earthquake occurred near Annandale, Virginia. Felt reports were primarily received from people in Fairfax County, Virginia; the District of Columbia; and Montgomery County, Maryland.
2011	23-Aug	5.8	Mineral, Virginia	Virginia and much of the East Coast experiences a widely-felt earthquake at 13:51 on Tuesday, August 23, 2011. According to the USGS, the epicenter of the event was located near Cuckoo, in Louisa county. With a magnitude of 5.8, this was the largest earthquake recorded by seismometers in Virginia. Between August 25, 2011 and January 1, 2012 876 aftershocks were recorded. The event resulted in a Federal Disaster Declaration for Virginia.

While it is important to identify historical earthquake occurrences within the Commonwealth, it is also important to acknowledge that impacts can be felt within the Commonwealth from outside sources. Effects from intraplate earthquakes in other states are often felt in Virginia. The New Madrid fault is considered a major seismic zone for the Southern and Midwestern US. The New Madrid fault had a series of devastating earthquakes from 1811 through 1812, and intensities of V and VI on the Modified Mercalli Intensity Scale could be felt throughout Virginia. In September 1886, a magnitude 7.3 earthquake occurred in Charleston, South Carolina. Intensities of II-V on the Modified Mercalli Intensity Scale were felt throughout Virginia. While these events occurred in other states, it is a great example of how the effects of earthquakes are felt over a very broad region east of the Rockies[5].

Figure 3.09-1 shows the epicenter locations of the 498 documented earthquakes in Virginia from 1774 through 2016.

Figure 3.09-1: Virginia Earthquakes - 1774-2016[6]

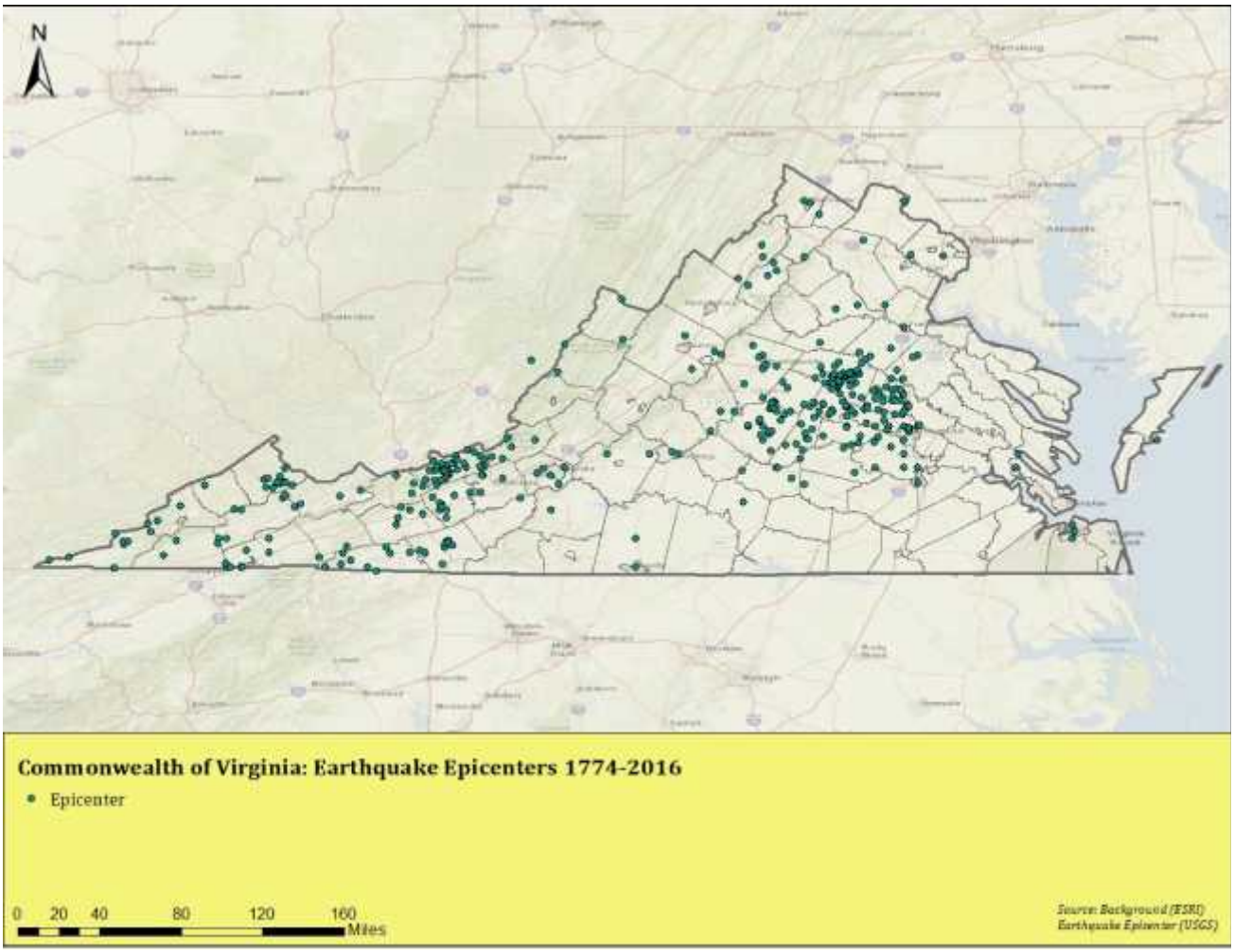
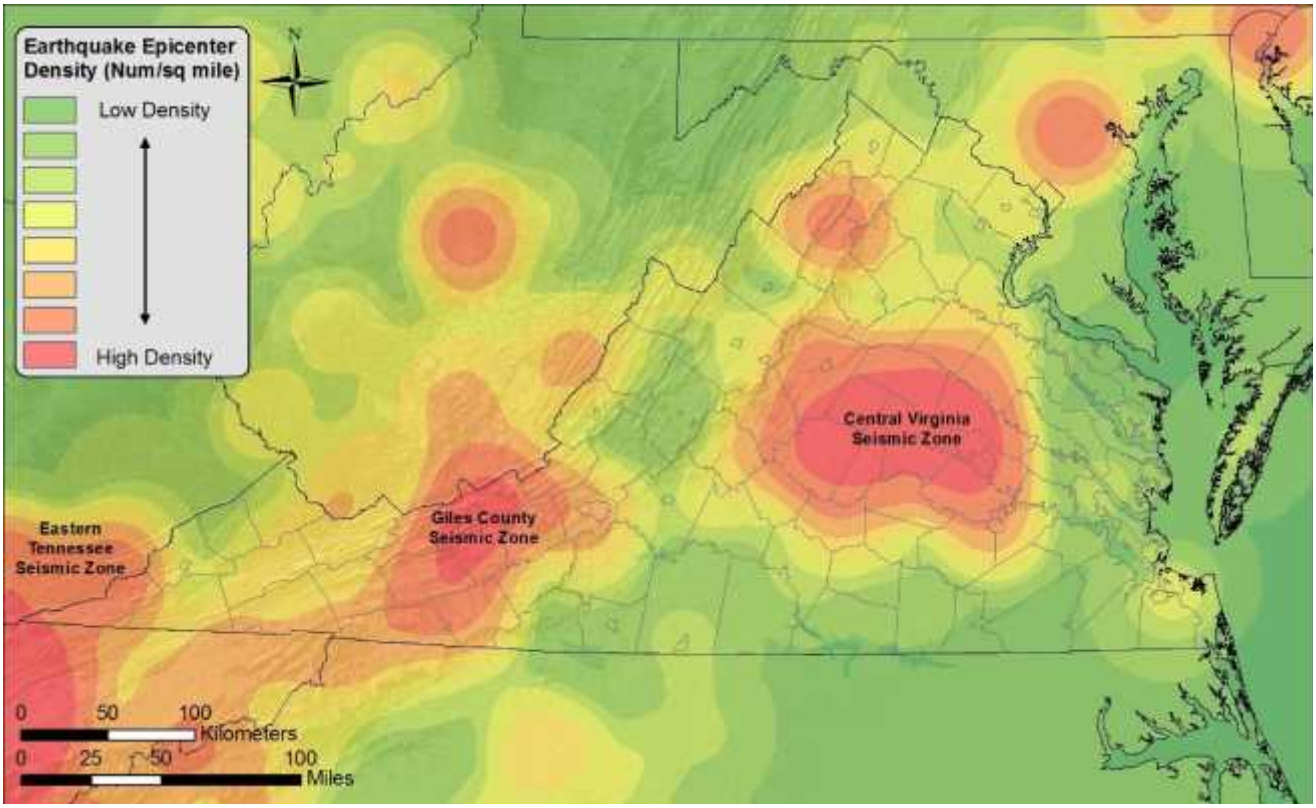


Figure 3.09-2 shows the main three zones in Virginia that are more susceptible to earthquakes. These zones are believed to be sources of most magnitude 6 or greater earthquakes during the past 1.6 million years around Virginia, though there has never been a quake of that magnitude recorded in Virginia.

Figure 3.09-2: Virginia Earthquake Epicenter Density[7]



Risk Assessment

In spite of extensive research and sophisticated equipment, it is impossible to predict an earthquake, although experts can estimate the likelihood of an earthquake occurring in a particular region. FEMA has developed a software suite, known as HAZUS-MH, for estimating potential losses from disasters. The HAZUS-MH earthquake model estimates damages and loss to buildings, lifelines, and essential facilities from scenario and probabilistic earthquakes.

Earthquake risk is related to the following factors[8]:

1. Ground motion;
2. Fault rupture under or near a building, often occurring in buildings located close to faults;

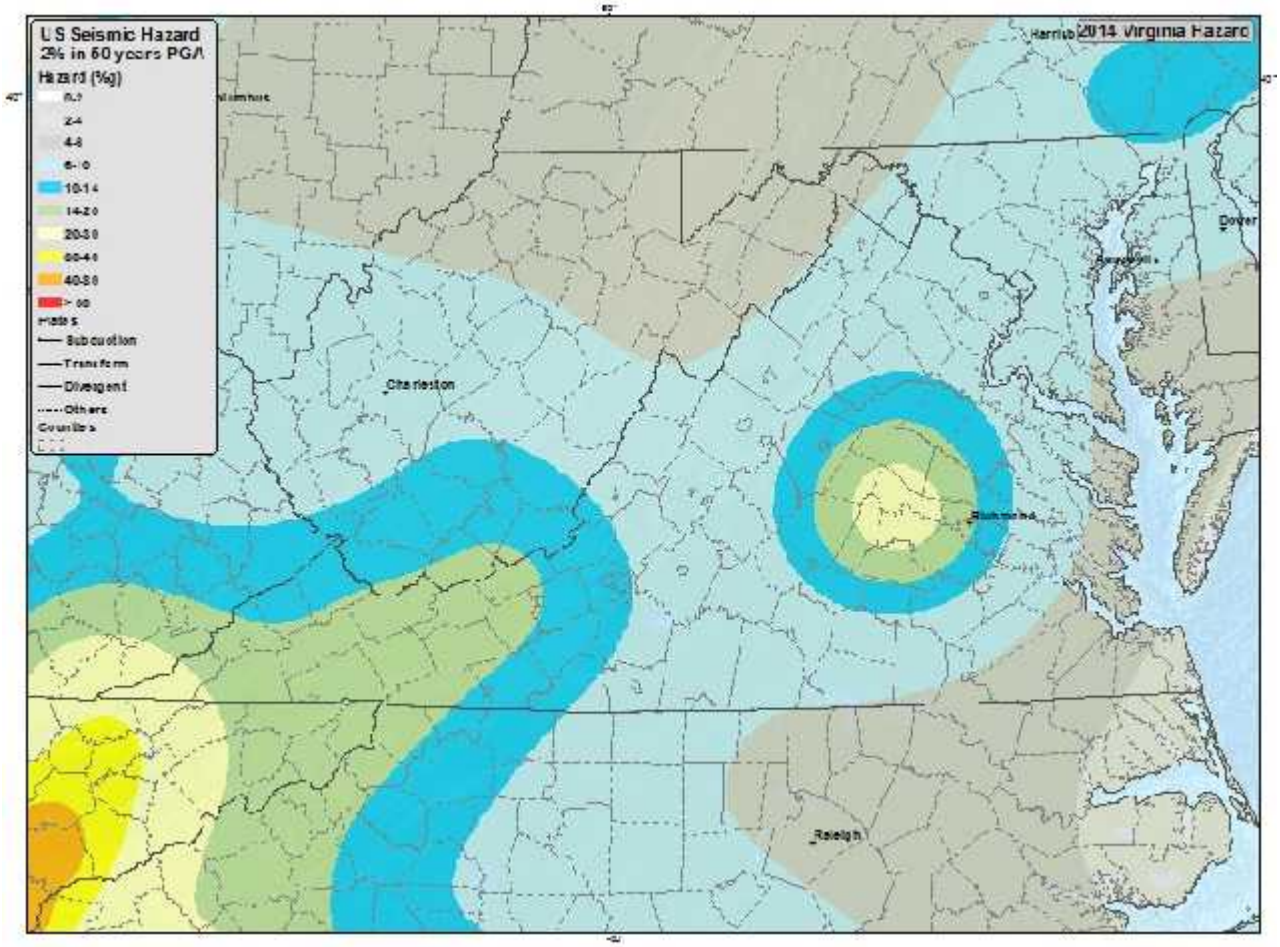
3. Reduction of the soil bearing capacity under or near a building;
4. Earthquake-induced landslide near a building; and
5. Earthquake-induced waves in bodies of water near a building.

Probability

Earthquakes are low probability, high-consequence events. Although earthquakes may occur only once in the lifetime of an asset, they can have devastating impacts. A moderate earthquake can cause serious damage to unreinforced buildings, building contents, and non-structural systems, and can cause serious disruption in building operations. Moderate and even very large earthquakes are inevitable, although very infrequent, in areas of normally low seismic activity. Consequently, in these regions buildings are seldom designed to deal with an earthquake threat; therefore, they are extremely vulnerable.

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as percent peak ground acceleration (%PGA), over a specified period of years. The severity of earthquakes is site specific, and is influenced by proximity to the earthquake epicenter and soil type, among other factors. Figure 3.09-3 shows the PGA zones Virginia.

Figure 3.09-3: Virginia Seismic Hazard: 2 Percent in 50 Years PGA Hazard[9]



The 100-year return period or one percent probability of happening in any given year, for a significant earthquake is very low, with southwest Virginia having a slightly higher chance of experiencing such an event. The 2500-year return period, or 0.04 percent annual chance of occurrence, is much more varied and similar to the two USGS earthquake zones discussed in the earthquake description. Southwest and central Virginia have an increased likelihood of experiencing a significant earthquake.

HAZUS-MH can be used to evaluate a variety of hazards and associated risks to support hazard mitigation. This revision of the Hazard Mitigation Plan utilizes Level 1 analysis for the earthquake module. Level 1 analysis involves using the provided hazard and inventory data with no outside data collection. This is an acceptable level of information for mitigation planning; future versions of this plan can be enhanced with Level 2 and 3 analysis, which requires more detailed and consolidated data than is currently available. Training is available for localities interested in performing HAZUS analysis at the Emergency Management Institute; FEMA

Region III also hosts periodic HAZUS training. VDEM staff can assist with determining needs and FEMA's Hazard Mitigation Technical Assistance Program could be a funding source for future workshops.

Impact and Vulnerability

Impacts from earthquakes can be severe and cause significant damage. Ground shaking can lead to the collapse of buildings and bridges; disrupt gas, life lines, electric, and phone service. Fatalities, injuries, and extensive property damage are possible vulnerabilities to this hazard. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, and dam failure.

Jurisdictional vulnerability and impact in the Commonwealth have been calculated in terms of total direct economic loss, as defined by HAZUS. This includes damage to building inventories, critical facilities, and transportation and utility lifelines, as well as the social and economic impacts. Additional information can be found in the Jurisdiction Risk portion of this section.

Risk

In April 2008, FEMA released report that updated a nationwide evaluation of earthquake losses in the US. The evaluation considered two measures of losses:

- Annualized Earthquake Losses (AEL) in any single year; and
- Annualized Earthquake Loss Ratio (AELR), which is a measure of seismic risk in relation to the value of the building inventory. The ratio is considered a more accurate picture of seismic risk and makes it easier to compare between regions.

FEMA's evaluation ranked Virginia 37th in the nation for AELR in the April 2008 revision and 28th in the national for AEL[10].

The Virginia Tech Seismological Observatory (VTSO) produced a report titled *Seismic Hazard Assessment for Virginia* in 1994 that was supported through funding by VDEM, FEMA, the US Nuclear Regulatory Commission, Virginia Power, and the USGS. This study provided a county-by-county assessment of the seismic hazards in Virginia. Geological conditions throughout much of the eastern part of the US are such that identification of seismogenic structures is difficult: no examples of surface faulting due to neotectonic earthquakes are known in the study region. However, it is possible to define areas with common geologic and seismic characteristics. These source zones are taken to represent areas within which available geological information suggests, or at least does not rule out, a common neotectonic environment. These zones include:

1. Giles County, VA
2. Central VA
3. Eastern TN
4. Southern Appalachians
5. Northern VA and MD
6. Central Appalachians
7. Piedmont-Coastal Plains
8. Charleston, SC
9. Appalachian foreland
10. New Madrid

Over much of the region, crustal structure potentially associated with seismicity is not resolved, and the geologic causes of earthquakes are poorly understood. The report summarizes, in depth, the source zones characteristics and hazard calculations used to arrive at the county-by-county analysis; 160 sites within Virginia and in adjacent parts of bordering states. Results show a higher probability of occurrence in the Giles County zone and Central Virginia.

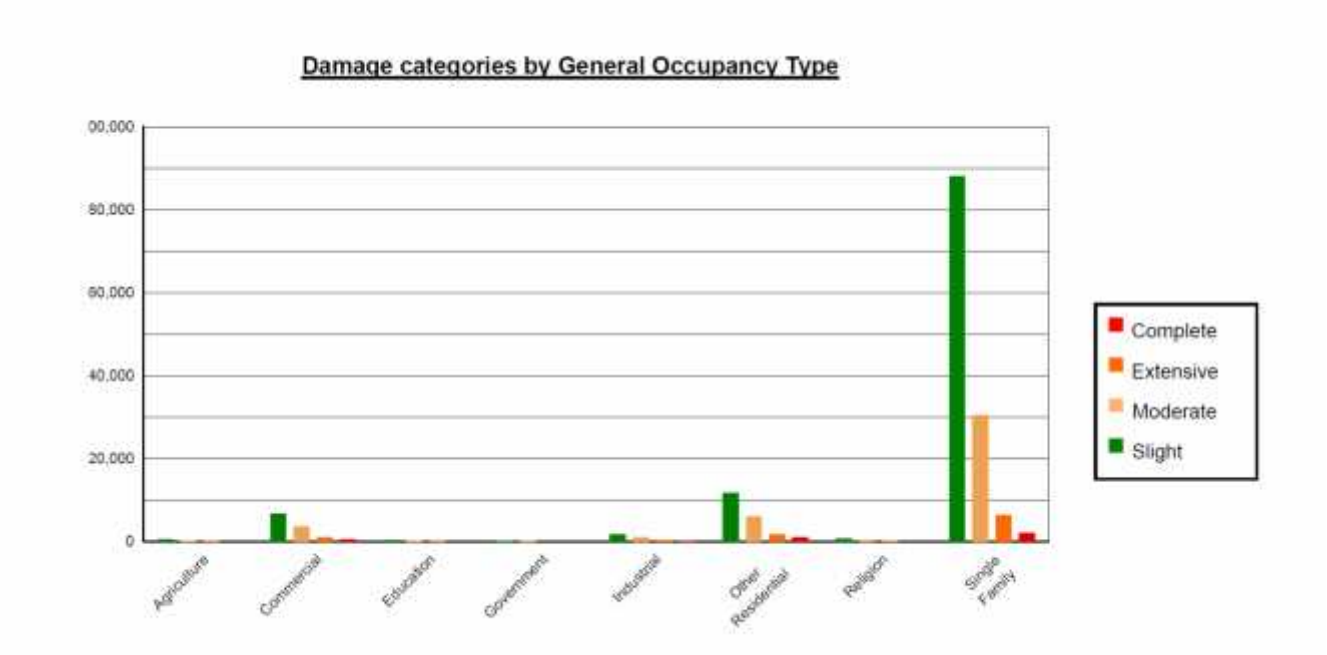
2011 Earthquake HAZUS-MH Model

The Mineral earthquake of 2011 was modeled in HAZUS-MH v.3.2. The epicenter of the earthquake was located close to Cuckoo, in Louisa County[11]. Based on the actual event, the scenario region was slightly more than 40,000 mi², encompassing the entire state of Virginia. The scenario placed the epicenter in Louisa County, at a depth of 6 km. The full report can be found in the appendix to this plan; highlights of it are included in the following pages.

Building Damage

HAZUS-MH estimated that approximately 54,861 buildings would be at least moderately damaged by the event; this is more than 2% of the buildings in Virginia. An estimated 3,602 buildings would be damaged beyond repair. Figure 3.09-4 shows the distribution of damage by type of occupancy.

Figure 3.09-4: 2011 Earthquake Scenario– Building Damage by Occupancy



As the figure shows, most building damage was found to be in residential structures.

Figure 3.09-5 provides the details of these findings by occupancy type; Figure 3.09-6 provides the details by building type.

Figure 3.09-5: 2011 Earthquake Scenario – Expected Building Damage Details by Occupancy

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	9,094	0.32	461	0.42	208	0.50	61	0.63	25	0.71
Commercial	131,904	4.71	6,708	6.09	3,471	8.34	1,051	10.91	433	12.02
Education	6,611	0.24	316	0.29	163	0.39	51	0.53	26	0.72
Government	5,129	0.18	229	0.21	110	0.26	26	0.27	10	0.28
Industrial	36,009	1.29	1,767	1.60	1,002	2.41	337	3.50	164	4.55
Other Residential	270,983	9.68	11,727	10.65	5,955	14.31	1,654	17.16	994	27.59
Religion	16,980	0.61	742	0.67	351	0.84	92	0.95	31	0.85
Single Family	2,323,771	82.98	88,125	80.06	30,364	72.95	6,365	66.06	1,919	53.29
Total	**2,800,480**		**110,075**		**41,624**		**9,635**		**3,602**	

Figure 3.09-6: 2011 Earthquake Scenario – Expected Building Damage Details by Building Type

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1,879,222	67.10	50537	45.91	10,173	24.44	1,163	12.07	114	3.15
Steel	93,719	3.35	4168	3.79	2,412	5.79	839	8.70	421	11.68
Concrete	17,230	0.62	709	0.64	389	0.94	121	1.25	59	1.64
Precast	6,541	0.23	343	0.31	272	0.65	92	0.96	26	0.72
RM	25,167	0.90	835	0.76	564	1.36	175	1.81	45	1.24
URM	604,706	21.59	44903	40.79	23,015	55.29	5,822	60.42	1,996	55.41
MH	173,894	6.21	8581	7.80	4,799	11.53	1,424	14.78	942	26.15
Total	**2,800,480**		**110,075**		**41,624**		**9,635**		**3,602**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Critical Facility Damages

HAZUS-MH estimated that the region has 24,163 hospital beds for use. On the day of the event, HAZUS-MH estimated that only 21,447 beds would be available for use; the event would cause an 11 percent reduction in hospital bed availability After 7 days, 96 percent of the beds would be back in service. Within 30 days, 99 percent would be available. Figure 3.09-7 shows the expected damages to critical facilities.

Figure 3-09.7: 2011 Earthquake Scenario – Expected Damages to Critical Facilities

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	127	0	0	126
Schools	2,712	27	9	2,647
EOCs	18	0	0	18
PoliceStations	382	1	0	372
FireStations	631	4	1	622

Transportation and Utility Damages

HAZUS-MH estimated damages to highways, railways, light rail, bus facilities, ferry facilities, port facilities, and airports. Of these, the scenario produces damages to only bridges – of the estimated 9,470 bridges in the scenario, 41 were estimated to be moderately damages and five were completed damaged. Figure 3.09-8 shows the expected damages to transportation systems.

Figure 3-09.8: 2011 Earthquake Scenario – Expected Damages to Transportation Systems

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	4,543	0	0	4,543	4,543
	Bridges	9,479	41	5	9,439	9,452
	Tunnels	13	0	0	13	13
Railways	Segments	2,580	0	0	2,580	2,580
	Bridges	184	0	0	184	184
	Tunnels	0	0	0	0	0
	Facilities	58	0	0	58	58
Light Rail	Segments	81	0	0	81	81
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	39	0	0	39	39
Bus	Facilities	54	0	0	54	54
Ferry	Facilities	20	0	0	20	20
Port	Facilities	298	0	0	298	298
Airport	Facilities	69	0	0	69	69
	Runways	93	0	0	93	93

Note: Roadway segments, railroad tracks, and light rail tracks are assumed to be damaged by ground failure only.

HAZUS-MH estimated damages to utility system facilities, pipelines, potable water, and electric power systems. Relatively minor utility system facility damages were estimated; no system was estimated to be completely damaged. Figure 3.09-9 shows the expected damages to utility system facilities.

Figure 3-09.9: 2011 Earthquake Scenario – Expected Damages to Utility System Facilities

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	135	2	0	133	134
Waste Water	297	4	0	285	293
Natural Gas	39	0	0	39	39
Oil Systems	28	0	0	28	28
Electrical Power	63	2	0	61	63
Communication	406	2	0	404	406

Utility system pipelines were also considered in this scenario. A relatively moderate number of leaks and breaks in potable water, waste water, and natural gas lines were estimated. No expected damages were estimated for oil pipelines. The expected pipeline damage details can be seen in Figure 3-09.10.

Figure 3-09.10: 2011 Earthquake Scenario – Expected Damages to Utility System Pipeline

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	319,618	3275	819
Waste Water	191,771	2347	587
Natural Gas	127,847	673	168
Oil	0	0	0

Finally, HAZUS-MH considered the expected performance of potable water and electrical systems that serve residential strictures. Potable water performed well, with all household service restored by day 30 after the event. For electrical, 31 households were estimated to still be without power at day 90 after the event. Figure 3-09.11 shows the details of this assessment.

Figure 3-09.11: 2011 Earthquake Scenario – Expected Potable Water and Electric Power System Performance

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	3,056,058	7,904	5,093	765	0	0
Electric Power		23,042	13,363	4,922	901	31

Debris Generated

As part of the model, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood and reinforced concrete/steel. HAZUS-MH estimated that a total of 2.32 million tons of debris would be generated by the event. Of that amount, 63 percent would be brick/wood, and 37 percent would be reinforced concrete/steel. Assuming a load of 25 tons per truck, this would equate to 92,600 truckloads of debris from this scenario.

Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that 4,049 households would be displaced. Of these, 2,471 people would be expected to seek temporary shelter in public shelters. Based on the 2010 Census population of 8,001,024, this equates to .03% of the state's population.

Casualties

HAZUS-MH estimated the number of people that would be injured or killed as a result of the scenario event. Casualty estimates are provided for three separate times of day – 2:00, 14:00, and 17:00. The 2:00 estimate considered the residential occupancy load as maximum. The 14:00 estimate considered that the educational, commercial, and industrial sector loads as maximum; the 17:00 estimate represents peak commute time.

Casualties are broken down into four severity levels that describe the level of injuries:

- Severity Level 1: injuries will require medical attention, but not hospitalization.
- Severity Level 2: injuries will require hospitalization but are not considered life-threatening.
- Severity Level 3: Injuries will require hospitalization and can become life-threatening if not promptly treated.
- Severity Level 4: Fatalities occur as a result of the earthquake.

Figure 3.09-12 provides the results of the casualty assessment.

Figure 3-09.12: 2011 Earthquake Scenario – Casualty Estimates

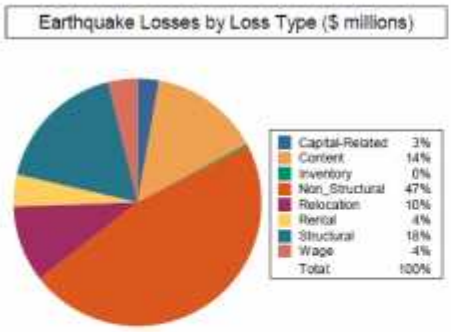
Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	25	6	1	2
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	34	9	1	2
	Other Residential	330	63	6	11
	Single Family	1,348	201	37	72
	Total	**1,737**	**359**	**45**	**87**
2 PM	Commercial	1,442	343	45	90
	Commuting	1	2	3	1
	Educational	690	146	22	42
	Hotels	0	0	0	0
	Industrial	252	64	9	18
	Other-Residential	62	12	1	2
	Single Family	267	58	8	15
	Total	**2,814**	**626**	**91**	**170**
5 PM	Commercial	1,031	216	31	66
	Commuting	24	50	05	10
	Educational	52	12	2	3
	Hotels	0	0	0	0
	Industrial	157	40	6	11
	Other-Residential	125	24	2	4
	Single Family	640	116	15	30
	Total	**1,929**	**469**	**113**	**125**

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. All told, HAZUS-MH estimated losses at $6.8 billion, including buildings and lifelines. 21 percent of the losses were related to business interruption in the scenario region. 67 percent of the losses were sustained by residential structures. Figure 3.09-13 provides additional details of these estimated losses.

Figure 3-09.13: 2011 Earthquake Scenario – Economic Loss Estimates



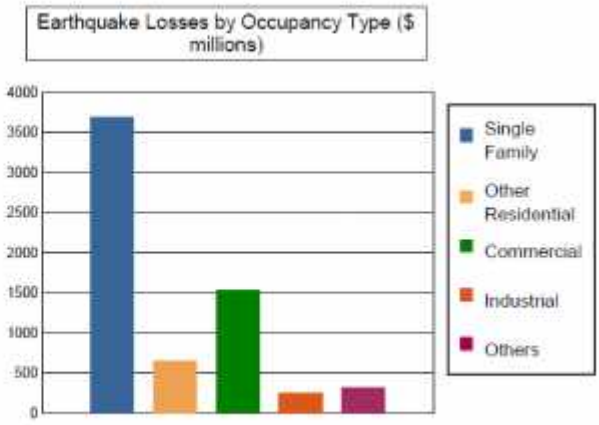


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	34.78	189.43	6.90	14.26	245.37
	Capital-Related	0.00	14.83	163.28	4.11	3.58	185.79
	Rental	109.85	54.46	97.92	2.45	5.64	270.33
	Relocation	379.46	42.05	146.45	14.14	50.69	632.79
	Subtotal	**489.31**	**146.12**	**597.09**	**27.60**	**74.17**	**1,334.29**
Capital Stock Losses							
	Structural	709.89	105.38	222.77	40.48	55.37	1,133.89
	Non_Structural	1,956.69	337.39	492.62	106.36	128.89	3,021.95
	Content	533.33	66.62	212.81	61.56	55.13	929.45
	Inventory	0.00	0.00	6.00	12.14	0.73	18.88
	Subtotal	**3,199.91**	**509.39**	**934.20**	**220.54**	**240.12**	**5,104.16**
	Total	**3,689.21**	**655.51**	**1,531.29**	**248.14**	**314.29**	**6,438.45**

For transportation and utility lifelines, HAZUS-MH only considers the direct repair cost for components; no losses are computed for business interruption due to utility outages. Figure 03.9-14 illustrates these findings for transportation systems; Figure 03.9-15 shows the findings for utility systems.

Figure 3-09.14: 2011 Earthquake Scenario – Transportation System Economic Loss Estimates

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	88,249.87	$0.00	0.00
	Bridges	10,562.19	$32.92	0.31
	Tunnels	213.23	$0.00	0.00
	Subtotal	**99,025**	**32.90**	
Railways	Segments	5,553.52	$0.00	0.00
	Bridges	26.59	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	154.45	$2.24	1.45
	Subtotal	**5,735**	**2.20**	
Light Rail	Segments	223.54	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	103.86	$2.50	2.40
	Subtotal	**327**	**2.50**	
Bus	Facilities	54.74	$0.60	1.10
	Subtotal	**55**	**0.60**	
Ferry	Facilities	26.62	$0.16	0.60
	Subtotal	**27**	**0.20**	
Port	Facilities	595.11	$2.56	0.43
	Subtotal	**595**	**2.60**	
Airport	Facilities	734.92	$12.07	1.64
	Runways	3,530.65	$0.00	0.00
	Subtotal	**4,266**	**12.10**	
	Total	**110,029.30**	**53.00**	

Figure 3-09.15: 2011 Earthquake Scenario – Utility System Economic Loss Estimates

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	4,180.80	$37.70	0.90
	Distribution Lines	6,392.40	$14.74	0.23
	Subtotal	**10,573.17**	**$52.44**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	18,395.60	$223.38	1.21
	Distribution Lines	3,835.40	$10.56	0.28
	Subtotal	**22,231.00**	**$233.94**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	39.50	$0.07	0.18
	Distribution Lines	2,556.90	$3.03	0.12
	Subtotal	**2,596.48**	**$3.10**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	2.60	$0.01	0.21
	Subtotal	**2.60**	**$0.01**	
Electrical Power	Facilities	6,444.90	$73.24	1.14
	Subtotal	**6,444.90**	**$73.24**	
Communication	Facilities	37.60	$0.18	0.48
	Subtotal	**37.76**	**$0.18**	
	Total	**41,885.91**	**$362.91**	

Because of the 2011 Mineral Earthquake, Virginia incurred $200-300 million in damages[12]. The Louisa County School Board received $41,826,395 in funding from FEMA's Public Assistance Program[13]. The earthquake also caused significant regional damage including the Washington Monument and the National Cathedral[14].

Virginia has not yet experienced a catastrophic earthquake. A magnitude six earthquake is possible for Virginia and would result in large scale structural failure. A probabilistic magnitude six earthquake was also modeled for the 2500-year return period, using HAZUS-MH. The modeled event shows that most damage would be limited to buildings, and that most of that damage would be to residential structures. HAZUS-MH estimated that more 5% of the buildings the region – an estimated 146,102 structures – would be at least moderately damaged by the event. Almost 3,000 structures would be damaged beyond repair. HAZUS-MH estimated that building-related damages would total $15.2

billion for the event, but that damages to transportation, utilities, and people would be negligible, as would the amount of debris generated by the events.

For complete details of both HAZUS-MH scenario models and results, please see the appendix.

State Facility Risk

At this time earthquake related losses to state facilities was not calculated; improved infrastructure and building data would lead to better analysis techniques in the future, and would allow for an increased HAZUS-MH analysis (to Level 2 or 3).

Critical Facility Risk

Detailed information about the critical facilities was not available for this revision of the plan as discussed in section 3.4. With more site-specific information (i.e., construction material), analysis could be completed to show the risk and annualized loss to the actual structure and function of the buildings.

Earthquake Risk to Energy Pipelines

Earth movement associated with earthquakes can cause pipelines to shift and possibly rupture resulting in dangerous leaks. Older, more brittle pipelines would be more susceptible to damage as the result of abrupt earth movements. For example, Columbia Gas confirmed that a gas leak in downtown Fredericksburg, Virginia was related to the 2011 Mineral earthquake. After the earthquake, Columbia Gas discovered the leak as part of a company emergency response pipeline safety survey that was conducted because of the earthquake. The survey showed that the natural gas was leaking into the storm and sanitary sewer system. This leak resulted in road closings and residence and other building evacuations until repairs were made[15].

Future Conditions Considerations

While there is no clear evidence as to any concrete link between changing climate and earthquake frequency or intensity – or even occurrence - changing climate could exacerbate cascading hazards or conditions after an event. For example, increased drought conditions could place more areas at risk for fire after an earthquake. Increased rainfall amounts could result in significant flooding in the event of a dam or levee breech because of an earthquake; this is a concern if the dam or levee is routinely functioning at capacity.

Jurisdictional Risk

Probabilistic earthquake events can be modeled in HAZUS-MH. HAZUS-MH was used to generate damage and loss estimates for the probabilistic ground motions associated with a return

period of 2500 years. The building damage estimates were then used as the basis for computing direct economic losses. These include direct building losses and business interruption costs.
The percentage of the total building stock in the jurisdiction was calculated as a percentage of the state's building stock, estimated by HAZUS. From there, a proportional amount of the total estimated building damages was assigned to each jurisdiction, based on their percentage of building stock. Finally, the losses were annualized over the return period of the scenario event. Fairfax County had the highest loss due to earthquake in this scenario; the Commonwealth of Virginia can expect **$6,092,952** in annualized losses due to earthquake.

Table 3.09-3: 2500-year Scenario – Expected Annualized Loss by Jurisdiction

Earthquake Annualized Loss Brackets			
> $750,000			
Fairfax County	$949,185		
$250,000 - $749,999			
Loudoun County	$267,938	Prince William County	$304,701
Virginia Beach	$331,889		
$150,000 - $249,999			
Arlington County	$192,663	Chesterfield County	$242,197
Henrico County	$246,568	Chesapeake	$160,934
Norfolk	$175,900	Richmond	$163,062
$100,000 - $149,999			
Stafford County	$100,793	Alexandria	$139,589
Newport News	$124,888		
$50,000 - $99,999			
Ablemarle County	$81,178	Fauquier County	$60,545
Frederick County	$54,593	Hanover County	$88,209
James City County	$60,502	Montgomery County	$59,869
Roanoke County	$70,844	Spotsylvania County	$92,593
York County	$55,576	Hampton	$92,388
Lynchburg	$55,245	Portsmouth	$61,901
Roanoke	$71,428		
$25,000 - $49,999			
Accomack County	$25,361	Augusta County	$46,984
Bedford County	$46,079	Bototourt County	$25,584
Campbell County	$33,326	Culpeper County	$33,345
Franklin County	$41,135	Gloucester	$26,700
Henry County	$33,393	Isle of Wight County	$26,410
Louisa County	$25,174	Pittsylvania County	$34,424
Rockingham County	$49,275	Shenandoah County	$37,463

Earthquake Annualized Loss Brackets			
Warren County	$28,973	Washington County	$34,979
Charlottesville	$31,819	Danville	$31,530
Harrisonburg	$31,053	Manassas	$29,088
Petersburg	$26,260	Suffolk	$58,259
Fairfax	$26,241		
< $24,999			
Alleghany County	$11,089	Amelia County	$7,163
Amherst County	$19,470	Appomattox County	$9,057
Bath County	$5,174	Bland County	$3,763
Brunswick County	$9,364	Buchanan County	$10,866
Buckingham County	$7,206	Caroline County	$19,579
Carroll County	$17,185	Charles City	$4,438
Charlotte County	$6,904	Clarke County	$13,302
Craig County	$3,425	Cumberland County	$5,909
Dickenson County	$6,717	Dinwiddie county	$16,817
Essex County	$8,152	Floyd County	$8,635
Fluvanna County	$17,945	Giles County	$10,570
Goochland County	$19,078	Grayson County	$9,177
Greene County	$11,354	Greensville County	$5,264
Halifax County	$21,424	Highland County	$2,309
King and Queen County	$3,919	King George County	$18,059
King William County	$11,366	Lancaster County	$11,625
Lee County	411,981	Lunenbueg County	$6,030
Madison County	$9,768	Mathews County	$7,007
Mecklenburg County	$21,038	Middlesex County	$10,148
Nelson County	$13,681	New Kent County	$14,224
Northmapton County	$9,521	Northumberland County	$13,187
Nottoway County	$9,033	Orange County	$24,457
Page County	$15,267	Patrick County	$10,793
Powhatan County	$19,766	Prince Edward County	$12,144
Prince George County	$21,183	Pulaski County	$22,401
Rappahannock County	$7,097	Richmond County	$5,481
Rockbridge County	$15,701	Russell County	$12,843
Scott County	$12,506	Smyth County	$17,776
Southampton County	$10,823	Surry County	$4,558
Sussex County	$5,885	Tazewell County	$23,890
Westmoreland County	$15,762	Wise County	$19,669
Wythe County	$17,703	Bedford	$5,119
Bristol	$12,656	Buena Vista	$4,432

Earthquake Annualized Loss Brackets			
Colonial Heights	$14,773	Covington	$4,221
Emporia	$4,366	Falls Church	$13,374
Franklin	$5,493	Fredericksburg	$21,834
Galax	$5,584	Hopewell	$14,839
Lexington	$5,861	Manassas Park	$9,238
Martinsville	$12,041	Norton	$3,280
Poquoson	$10,148	Radford	$9,726
Salem	$21,273	Staunton	$18,505
Waynesboro	$15,762	Williamsburg	$11,625
Winchester	$23,202		

The hazard ranking for earthquake is based on events reported in the NCEI *Storm Events Database* and a generalized geographic extent. The geographic extent ranking category was assigned a Low ranking for all jurisdictions; this was based on the 2500-year return period used in the HAZUS-MH scenario, which represents a 0.04 percent annual chance of occurrence in any given year. The ranking parameters used in the risk assessment are illustrated in Figure 3.10-8, along with the total ranking score. Most of the Commonwealth is in the medium and medium-low risk categories. See section 3.5 for more information on the methodology used for ranking hazards.

The ranking results and HAZUS annualized losses highlight similar areas that are at a somewhat higher risk due to earthquake. These areas include Northern Virginia, Richmond City, and Southwest Virginia.

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

Of the 20 local plans, 18 provide hazard rankings for earthquake. One considers the hazard but does not rank it, and one does not consider the hazard. Six local plans included annualized loss estimates for earthquake; all but one of these ranked earthquake as low risk. These estimates were based on a HAZUS-MH module.

Comparison with Local Ranking

The Cumberland Shenandoah PDC, LENOWISCO, and NOVA plans ranked earthquake as a medium hazard for their region.

Two plans either did not include earthquake as a hazard or did not provide a ranking for it, judging the risk to be negligible. All other plans ranked the hazard as low. The 2018 statewide analysis has ranked earthquake as medium-low. Section 3.6 includes the complete ranking of all the local plans.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general terms. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). Such data would greatly improve ability to identify impact, vulnerability, and loss estimates due to earthquakes.

Table 3.09-4: Earthquake Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Albemarle	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Alexandria, City of	Medium-High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Alleghany	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Amelia	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Amherst	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Appomattox	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Arlington	High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Augusta	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Bath	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Bedford	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Bland	Low	Low	Low	Low	Low	Medium-Low	Low	Low

Botetourt	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Brunswick	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Buchanan	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Buckingham	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Campbell	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Caroline	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Carroll	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Charles City	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Charlotte	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Charlottesville, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Chesapeake, City of	High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low

Chesterfield	High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Clarke	Low	Medium	Low	Low	Low	Medium-Low	Low	Low
Colonial Heights, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Covington, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Craig	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Culpeper	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Cumberland	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Danville, City of	Medium	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Dickensen	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Dinwiddie	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Emporia	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Essex	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Fairfax	High	High	Low	Low	Low	Medium-Low	Low	Medium-Low

Fairfax, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Falls Church, City of	Low	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Fauquier	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Floyd	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Fluvanna	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Franklin	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Franklin, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Frederick	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Fredericksburg, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Galax, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Giles	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Gloucester	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Goochland	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low

Grayson	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Greene	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Greensville	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Halifax	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Hampton, City of	Medium-High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Hanover	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Harrisonburg, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Henrico	High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Henry	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Highland	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Hopewell, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Isle of Wight	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
James City	Medium-High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low

King and Queen	Low	Low	Low	Low	Low	Medium-Low	Low	Low
King George	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
King William	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Lancaster	Low	Medium	Low	Low	Low	Medium-Low	Low	Low
Lee	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Lexington, City of	Low	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Loudoun	High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Louisa	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Lunenburg	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Madison	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Manassas, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Manassas Park, City of	Low	High	Low	Low	Low	Medium-Low	Low	Low

Martinsville, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Mathews	Low	Medium	Low	Low	Low	Medium-Low	Low	Low
Mecklenburg	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Middlesex	Low	Medium	Low	Low	Low	Medium-Low	Low	Low
Montgomery	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Nelson	Low	Low	Low	Low	Low	Medium-Low	Low	Low
New Kent	Low	Medium	Low	Low	Low	Medium-Low	Low	Low
Newport News, City of	High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Norfolk, City of	High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Northampton	Low	Medium	Low	Low	Low	Medium-Low	Low	Low
Northumberland	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Norton	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Nottoway	Low	Low	Low	Low	Low	Medium-Low	Low	Low

Orange	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Page	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Patrick	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Petersburg, City of	Medium	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Pittsylvania	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Poquoson	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low
Portsmouth, City of	Medium-High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Powhatan	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Prince Edward	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Prince George	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Prince William	High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Pulaski	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Radford, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low

Rappahannock	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Richmond	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Richmond, City of	High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Roanoke	Medium-High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Roanoke, City of	Medium-High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Rockbridge	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Rockingham	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Russell	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Salem, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Scott	Medium	Low	Low	Low	Low	Medium-Low	Low	Low
Shenandoah	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Smyth	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Southampton	Low	Low	Low	Low	Low	Medium-Low	Low	Low

Spotsylvania	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Stafford	Medium-High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Staunton, City of	Medium	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Suffolk	Medium-High	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Surry	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Sussex	Low	Low	Low	Low	Low	Medium-Low	Low	Low
Tazewell	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Virginia Beach, City of	High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Warren	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Washington	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Waynesboro, City of	Medium	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Westmoreland	Low	Medium	Low	Low	Low	Medium-Low	Low	Low
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Low	Low

Winchester, City of	Medium	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Wise	Medium	Medium	Low	Low	Low	Medium-Low	Low	Low
Wythe	Medium	Medium	Low	Low	Low	Medium-Low	Low	Low
York	Medium-High	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low

For the 2018 plan, the overall hazard ranking for earthquakes is medium-low.

Table 3.09-5: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Local impacts expected to be serious for those who are inside poorly build structures close to the event, and light to moderate in areas with better construction and that are further away from the event.
Health and Safety of Response Personnel	Local impacts expected to be serious for those who are inside poorly built structures close to the event, and light to moderate in areas with better construction and that are further away from the event.
Continuity of Operations	Damage to facilities/personnel in the area of the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure in the area of the event may be extensive.
Delivery of Services	Disruption of lines of communication and damage to facilities and/or roads may have considerable impacts on the delivery of services.
The Environment	The environment may be subject to extensive damage due to secondary effects such as HAZMAT debris, broken utility lines, and movement of soil.
Economic and Financial Condition	Local economy and finances moderately impacted, duration depends on magnitude of event.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient.

Endnotes

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Section 3.10: Flooding

Description



Wise County, Virginia Flooding
July 2011
Source: Jack Tolbert, VDEM

Flooding occurs when an area that is normally dry becomes inundated with water. Flooding may occur as an overflow of streams or rivers, an overflow of inland and tidal waters, mudflows, or due to the failure of engineered structures like dams or levees. Flooding can occur at any time of the year. Rapid snowmelt can cause flooding in the winter. Torrential rains from hurricanes, tropical systems, and seasonal rain patterns can cause flooding at any time of year, but is typically most prevalent in the spring, summer and fall.

Flooding is typically characterized in terms of severity and frequency of occurrence. Small floods happen frequently, and large floods happen less frequently. A certain intensity of flood, as measured in terms of flood depth or inundated area, is typically described by its frequency of occurrence; for example, the one percent annual chance flood. As the name indicates, such a flood has a one percent probability of occurrence (or exceedance) in any given year. A one percent annual chance flood is interchangeably called the 100-year flood, the 100-year terminology is misleading and is no longer the practice among floodplain managers. For most regulatory and hazard identification purposes, the one percent annual chance flood is a common baseline flood.

Flooding is one of the most common hazards that occur in both the US and Virginia. Between 1957 and 2016, 38 of the 64 federal disaster declarations in Virginia included flood impacts[1]. Riverine and coastal flooding poses significant risk to Virginia. Virginia's most urbanized areas are in broad, flat coastal plains, prone to both coastal and riverine flooding. In the mountains of the western part of the state, most urban development occurs along the relatively flat river valleys, which are at risk for riverine flooding and occasional flash flooding.

Storm Surge Hazards

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide. Storm surge occurs when strong onshore winds push water from an ocean, bay or inlet onto the land. In addition, coastal areas experience flooding from overland flow, ponding, and inadequate storm

water drainage. Storm surge may arise from tropical cyclones (hurricanes and tropical storms) or Nor'easters (extra tropical storms). In Virginia, all coastal areas are susceptible to storm surge, especially the areas with flat topography and low land elevations. With highly populated and developed communities, the Hampton Roads region is particularly at risk to flood damage. As an example, the Sewells Point gage in Norfolk, the 1933 Hurricane and Hurricane Isabel recorded storm tide elevations of eight feet and 7.9 feet MLLW, respectively, and storm surge at 5.8 and 4.8 feet MSL, respectively. Storm surge hazards also occur during nor'easters, as these coastal storms can be large, slow moving, and of long duration, with heavy rainfall and persistent wind. While the storm surge associated with hurricanes will typically last for a single tide cycle, the surge associated with nor'easters can last for multiple tide cycles.

Coastal Erosion Hazards

Coastal erosion is a natural process that can be accelerated by flooding and storm-related wave action. While tidal surge events can cause nominal increases in the rate of erosion, large-scale storm events generating an extensive surge will cause a rapid acceleration in coastal erosion rates. Accelerated erosion in areas with no natural or man-made protective features is more likely to increase severe impacts to infrastructure. Through loss of land and undercutting, infrastructure such as pipelines, piers, roadways, and other structures can be significantly damaged or destroyed.

The majority of the coastal communities considered erosion in their local hazard mitigation plans. Accomack-Northampton PDC ranked coastal erosion as a high risk hazard; Northern Neck PDC ranked it as a medium risk hazard. Richmond-Crater and Northern Virginia ranked coastal erosions as a low risk hazard; the remaining plans did not provide a rank for coastal erosion or considered its effects negligible. The 2010 and 2013 HIRA sub-committees directed to limit the statewide hazard mitigation plan's treatment of coastal erosion to a brief definition and discussion; the Advisory Committee and Working Group affirmed that treatment for this revision. Most of the coastal communities and agencies have done, and continue to do, detailed coastal analysis that is not within the scope of this plan.

Sea Level Rise

Sea level rise is a concern for coastal communities; as sea level increases so do the impacts of coastal flooding and storm surge. 'Just as water levels rise and fall, the earths crust in many regions also moves up or down, adding or subtracting from the apparent sea level trend'[2]. For Sewells Point, for the years 1927 to 2016, NOAA shows a sea level rise trend of 1.51 feet per century. The Hampton Roads region generally has the highest rates of sea-level rise on the Atlantic Coast, where data indicate that land subsidence has been responsible for more than half the relative sea-level rise measured in the region. Local land subsidence can be connected to the comet or meteor that caused a crater 35 million years ago and groundwater withdrawals from paper mills in Franklin and West Point, Virginia.[3] [4] Also, researchers, including Old Dominion

University, have found the slowing down of the ocean circulation, more specifically the Gulf Stream, may also contribute to the regional increase in sea level rise.[5]

Riverine Flood Hazards

There are 52,232 miles of free-flowing streams and rivers within the Commonwealth. Riverine flooding occurs when rain events or rapid snowmelt add more water into a waterway than it can hold. This causes the water to rise, overtopping the river bank, and flooding agricultural fields, roads, or populated areas[6].

Flash Flood Hazards

Flash floods typically result from large amounts of rain occurring in short periods of time. Heavy rain events can quickly exceed the capacity of the ground to soak up the water, and the receiving streams are unable to contain the water within their banks. Urbanized and developed areas could experience an increase in flash flooding due to the increased amount of impermeable surfaces. Flash flooding is particularly dangerous in steep mountain valleys or other confined areas where there is little floodplain storage to attenuate the flood volume.

The Virginia Department of Emergency Management operates the Integrated Flood Observation and Warning System (IFLOWS) network consisting of 279 rain gauges and 72 stream gauges located primarily along the I-81 corridor in western Virginia. The gauges collect and report data in real time to local, state, and federal agencies. The National Weather Service relies on the data to support their decision-making process for issuing flash flood watches and warnings. The participating local governments rely on the data to make decisions regarding the protection of life and property[7].

Storm Water Flooding Hazards

Storm water can be a cause of or a contributing factor to flash or urban flooding. Flooding increases as solid surfaces replace permeable surfaces or natural green spaces, as storm water is unable to filter into the landscape. Storm water deposits sediment that decreases the depth and flow capacity of waterways (natural and manmade), further increasing flooding. Storm water runoff flooding is most evident in areas where urbanization has occurred. Changes in land use have a major impact on both the quantity and quality of storm water runoff. Urbanization, if not properly managed, can dramatically alter the natural hydrology of an area because it increases impervious cover. Impervious cover decreases the amount of rainwater that can naturally infiltrate into the soil, thereby increasing the volume and rate of storm water runoff.

Note: At the direction of the Advisory Committee and the Working Group, tsunami was removed from this update, based on the lack of historical occurrence and the limited likelihood of future occurrence. After the review of the initial draft, urban flooding was also removed from this update, as the hazard is sufficiently accounted for through both flash and storm water flooding.

Historic Occurrence

Historical occurrences of flooding have been extensively recorded by local, state and federal agencies. Table 3.10-1 of significant flood events is based on available records from VDEM, the National Weather Service, and local plan narratives. VDEM currently maintains a narrative inventory of historical weather events, including flooding and hurricanes on their website. Federal disaster declarations related to flooding are available in Section 3.3 of this plan.

Table 3.10-1: Historical Flood Events from 1862 through 2016

Period of Occurrence	Description
February 22, 1862	The Clinch River crested at nearly 23 feet above gauge level at Cleveland. (Cumberland Plateau)
March, 1826	Greatest known flood on Clinch River in Tennessee and far southwest Virginia (Cumberland Plateau PDC)
March 1867	A large flood was reported in the Town of Dungannon, but no specific records exist other than word of mouth. (Cumberland Plateau PDC)
September 1870	There was flooding in the Shenandoah River. A storm produced heavy rains causing 12 fatalities and washing away at least 23 buildings in Page and Clarke Counties. The town of Castleman's Ferry was completely wiped out and never rebuilt. (North Shenandoah RC)
May 1871	A massive flood caused the third floor of the Capitol building in Richmond to collapse, killing 60 people and causing injury to 250.
September 30, 1896	A period of heavy rainfall hit the Shenandoah region, especially affecting the City of Staunton. In Staunton, many homes and structures were swept away by floodwaters and three deaths occurred.
June 22, 1901	Southwest Virginia was affected as the Clinch River flooded due to storms in the headwater regions. The floods caused a great deal of damage and several deaths. (Cumberland Plateau)
March 1, 1902	As the Clinch River flooded, it caused landslides and washouts along railways running through the region. (Cumberland Plateau)
April 1905	Franklin County was affected. There were large floods that caused heavy damage to croplands and structures in the floodplains. (West Piedmont PDC).
April 27, 1905	Largest Flood on record recorded on the Banister River. (West Piedmont PDC).
August 1906	Highland County experienced extensive crop and property damage and one loss of life due to stream flooding after a prolonged wet period. (CSPDC)
June 14, 1907	The Clinch River reached 20 feet above gauge level and caused extensive crop damage (Cumberland Plateau)
January 29, 1918	Clinch River Ice Tide. Major flooding occurred when a storm hit while the ground was covered with snow. (Cumberland Plateau)
May 12, 1924	Heavy rains over a period of several days caused the Shenandoah river to rise 34 feet in some locations, causing several boat rescues of stranded flood victims. Total damages to roads alone were over $500,000. (Northern Shenandoah)
August 23, 1933	Flooding occurred due to tidal surges in the Hampton Roads area, with surges of over 9 feet recorded in Portsmouth. (Chesapeake)

Period of Occurrence	Description
March 18-19, 1936	The Great Spring Flood - The Potomac, Shenandoah, Rappahannock, James and York Rivers flooded. The months prior to the flood were marked with low temperatures and heavy snowfalls. Warmer temperatures and rainfall in March resulted in melting snow and rising rivers.
April 26-27, 1937	Heavy rains caused widespread flooding. Damages to roads and bridges approached half a million dollars and agricultural losses exceeded $1 million.
October 13, 1937	The largest flood on record in the City of Martinsville and Town of Bassett. Hundreds of homes in the county were inundated with floodwaters (West Piedmont PDC)
August 13-18, 1940	Because of four rain events, the Blackwater River crested approximately 10 feet above flood stage. The Meherrin River crested 31.5 feet above flood stage in Emporia. (City of Franklin)
October 15-17, 1942	This flood is considered one of the worst river flood in Virginia. Damages to the Rappahannock neared $2.5 million and $4.5 million on the Potomac River. More than 1,300 people were left without homes in Albemarle, Spotsylvania, Stafford and Warren Counties. Transportation was disrupted for three days and severe damages and losses occurred to Virginia agriculture
August 18-20, 1955	Hurricane Diane - Heavy rains resulted in flash flooding along the Piedmont and in the Shenandoah Valley
January 30, 1957	Clinch River - The highest known flood in its time, this flood caused over $24,000 in damages in Russell County. (Cumberland Plateau PDC)
October 1957	A nor'easter brought extremely high tides to the Town of Wachapreague on the Eastern Shore up to four feet above normal. (Eastern Shore PDC)
March 1962	The Ash Wednesday Storm of 1962 was a nor'easter that caused over $200 million (1962 dollars) in property damage and significant coastal erosion from North Carolina to Long Island[8].
March 12, 1963	Clinch River - A major flood along the Clinch River forced over 100 families to evacuate their homes and washed away two bridges. Two homes were completely washed away by floodwaters. (Cumberland Plateau PDC).
August 20, 1969	Camille entered Virginia as a tropical depression, and had picked up enough moisture from the warm Gulf Stream that when she slowed over the Commonwealth, her thunderstorms trained for 12 hours. Nearly 31 inches of rain fell with devastating results. The ensuing flash flood and mudslide killed 153 people, mostly in Nelson County where 113 bridges washed out. Flooding cut off all communications between Richmond and the Shenandoah Valley. The City of Waynesboro on the South River saw eight feet of water downtown and Buena Vista had more than five feet. Damage was estimated at $113 million.
June 21, 1972	Remnants of Hurricane Agnes dropped heavy rains across the region. Sixteen inches of rain was recorded in Chantilly in Fairfax County, and both the Potomac and James rivers experienced flooding. The Richmond City water supply, sewage treatment, electric and gas plants were inundated. Only one of the five bridges crossing the James survived; the downtown section was closed for several days. More than 60 counties and 23 cities in the Commonwealth qualified for federal disaster relief. Sixteen people died in Virginia and damage was estimated at $222 million.

Period of Occurrence	Description
June 23, 1972	Flooding caused over $1 million in damages in the City of Danville. In the surrounding counties, the damage was primarily agricultural. (West Piedmont PDC).
October 10, 1972	A storm produced up to 10 inches of rain in some locations causing the Shenandoah River to rise over 30 feet above flood stage in northern Shenandoah. (North Shenandoah Valley RC)
November 1977	A flood along the Middle Fork Holston River caused over $8.6 Million in estimated damages in Smyth County. Many buildings had several feet of floodwaters in them. (Mt Rogers PDC)
November 4-7, 1985	Election Day Flood described earlier in the discussion on federal disaster declarations (section 3.3).
September 7, 1987	Henry County. Severe flooding primarily in the Bassett, Stanleytown, Collinsville, and Fieldale areas. Approximately 500 residents were evacuated with over 150 housed in public shelters. The damage total $6.1 million with $4.6 million not covered by insurance. This estimate does not include damage to the 36 state roads in the county that suffered damage. (West Piedmont PDC).
June 6, 1992	A significant flood occurred in Giles County as the result of 6 inches of rainfall. (NRV)
June 1995	A period of sustained rainfall caused flash flooding and several landslides. In Madison County, 30 inches of rain were recorded over 16 hours. In other locations, 25 inches of rain were recorded in a period as short as five hours. Flooding also occurred further to the southwest in Augusta County, which received 12 inches of rain in 11 hours, and in Glasgow, VA, where river flooding became a problem. (Central Shenandoah) In Albemarle County, over $2 million in damages were reported. (Thomas Jefferson PDC).
January 19-22, 1996	The Great Melt Down described earlier in the discussion on federal disaster declarations (section 3.3).
September 5-6, 1996	Hurricane Fran caused all rivers in the central part of the state to experience major flooding, record level flooding occurred on the Dan River in South Boston, and on the Shenandoah River in Page County. Page County, Rockingham County, Warren County, and the City of Alexandria all experienced major flooding.
June 26, 1997	Frederick County. A strong downburst produced winds up to 100 mph, which uprooted many trees and damaged fifty structures (Northern Shenandoah Valley RC).
February 6, 1998	Much of the eastern portion of the state was affected by a slow-moving nor'easter. This storm caused severe coastal flooding in the Hampton Roads area and on the Eastern Shore. The causeway to Chincoteague Island was closed and the entire island was submerged under floodwaters. Several streets in Norfolk were closed due to over three feet of water, and at least one family in Gloucester County was rescued by rowboat. There were no reported injuries or fatalities, but damages were estimated at $75 million. (Eastern Shore HMP)
September 148, 1999	Hurricane Floyd described earlier in the discussion on federal disaster declarations (section 3.3).
June 24, 2000	Several roads within the county were washed out as a result of flash flooding in Southampton County. (City of Franklin)

Period of Occurrence	Description
September 3, 2000	Fredericksburg - A flash flood hit the city after more than two inches of rain, which damaged the first floor of several homes and apartments. Also, vehicles became submerged in floodwaters causing several drivers to be rescued. (RADCO)
July 8, 2001	Thunderstorms in Tazewell County caused flash flooding, which resulted in an estimated $15 Million in damages.
March 17, 2002	Floods caused a state of emergency declaration for southwest Virginia. (Mt Rogers PDC).
April 17, 2002	Severe storms and flooding occurred in Smyth, Washington, and Wythe Counties. (Mt Rogers PDC).
July 25, 2002	A flash flood affected the Town of Pembroke (Giles County) causing $367,000 in damages and closing Route 460. (NRV PDC)
May 26, 2003	Heavy rains caused the flooding of at least three roads in Halifax County. One person was injured when the vehicle he was driving was swept away as the road gave way. (Southside PDC)
2003	Hurricane Isabel described earlier in the discussion on federal disaster declarations (section 3.3).
2004	Tropical Depression Gaston described earlier in the discussion on federal disaster declarations (section 3.3).
October 2006	A nor'easter impacted the southeastern portion of the state causing minor flooding in the City of Chesapeake and the City of Hampton. The City of Franklin along the Blackwater River experienced their 2nd flood of record at 22.77 feet. This happened only 7 years after the city experienced their flood of record during Hurricane Floyd which crested at 26.27 feet (flood stage is 12 feet).
June 16, 2006	Cameron Run in Fairfax County flooded, which resulted in 158 homes declared uninhabitable and $11 million in estimated damages.
September 2006	Tropical Depression Ernesto described in the discussion of federal disaster declarations (section 3.3).
May 2008	A strong low pressure system caused widespread flooding throughout the central portion of the state. Numerous roads were closed from the northern Virginia area in the north to the City of Danville in the south. In Culpeper County, several people were evacuated from their homes due to the floods.
November 2009	Severe storms and flooding associated with Tropical Depression Ida and a November nor'easter described in the discussion of federal disaster declarations (section 3.3).
August 2011	Flooding associated with Hurricane Irene described in the discussion of federal disaster declarations (section 3.3).
September 2011	Flooding associated with remnants of Tropical Storm Lee described in the discussion of federal disaster declarations (section 3.3).
October 2012	Hurricane Sandy caused heavy rainfall and flooding along Virginia's Eastern Shore. Severe coastal flooding and storm surge inundated many areas along the coast as the storm moved north, causing millions of dollars in damages to residences and businesses.

Period of Occurrence	Description
May 2014	A storm system with periods of moderate to heavy rainfall and the possibility of severe thunderstorms capable of producing damaging winds began moving through the Commonwealth late on 15 May, and was forecast to exit the Commonwealth late 16 May. Bands of moderate to moderate to heavy rainfall moved out of Virginia with light rain showers forecast to continue until late this afternoon/early evening across areas of northwest Virginia, northern Virginia, central Virginia, and eastern Virginia. Over a 24-hour period, southwest and west central Virginia received 2 to 4 inches of rain, northwest and northern Virginia received 3 to 5 inches of rain, and central and eastern Virginia received 2 to 4 inches of rain which has resulted in flooding of multiple primary and secondary roads across Virginia. There were multiple urban area and small streams Flood Warnings in effect across Virginia.
September 2014	Areas of Southeast Virginia were impacted by rain from a low pressure system that began on Monday, 8 September and to 9 September. Roadways and two apartment complexes were affected by flooding and rising waters. Rainfall amounts range from four to eight inches with locally higher amounts up to 10-12 inches.
March 2015	Snow melt and rainfall combined to cause flooding in areas of Southwest Virginia. The City of Norton, Dickenson County, Tazewell County, Buchanan County, and Wise County and the towns of Big Stone Gap, Pound, and Coeburn reported rivers, streams, and creeks approaching flood stage, with some flooding and rock slides occurring into roadways.
July 2015	Scattered thunderstorms began impacting much of the Commonwealth as a cold front moved into the area beginning July 5th. These storms brought 2-3 inches of rainfall in 24 hours to the southwestern portion of the state resulting in flooding in Tazewell County. Pocahontas, Boissevain, and Abbs Valley areas were the primary areas of impact. On July 13, 2015, scattered thunderstorms and a line of severe thunderstorms brought 2-4 inches of rainfall resulting in flash flooding in Shenandoah County and the surrounding area.
June 2016	The Governor issued a State of Emergency declaration for record flooding of the Jackson River Watershed. The Jackson River crested more than five feet above flood stage on June 23, 2016. Most of downtown Covington was evacuated, and shelters were established. This event was part of a large storm system that also devastated parts of neighboring West Virginia.
October 2016	Hurricane Matthew affected areas from Southern Florida to Southeast Virginia. Heavy rains spread inland through Virginia. 14.21 inches of rainfall was reported in the south eastern portion of the commonwealth.

Flood Mapping Efforts

Due to enormous flood losses in the latter half of the 20th century, the federal government made a shift in focus from flood control to flood management. The goal of flood management is to prevent life loss, reduce flood damage and formulate effective plans for recovery and

rehabilitation efforts. This transformation from flood control to flood management resulted in changes and improvements to federal policies. One of the major undertakings was to produce flood maps for the entire US.

In 1968, the US Congress created the National Flood Insurance Program (NFIP). Their intent was to reduce future damage and to provide protection for property owners from potential losses through an insurance mechanism that allows a premium to be paid by those most in need of the protection. Later, FEMA produced Flood Insurance Rate Maps (FIRMs) that show areas subject to flooding. The flood risk information presented on the FIRMs is based on historic, hydrologic, and hydraulic data, as well as open-space conditions, flood-control works, and development.

To prepare the flood maps, FEMA generally conducts engineering studies referred to as Flood Insurance Studies (FIS). Using the information gathered in these studies, FEMA engineers and cartographers delineate Special Flood Hazard Areas (SFHAs) on flood maps. SFHA are subject to inundation by a flood that has a one percent or greater chance of being equaled or exceeded in any given year. The one percent annual chance flood is a regulatory standard used by federal agencies and most states, to administer floodplain management programs. The one percent annual chance flood is also used by the NFIP as the basis for insurance requirements nationwide[9]. The main recurrence intervals used in the FIS are shown below in Table 3.10-2, where the 1% and 0.2% chance floods are only shown on the FIRMs.

Table 3.10-2: Annual probability based on flood recurrence intervals

Flood Recurrence Interval	Annual Chance of Occurrence
10-year	10.0%
50-year	2.0%
100-year	1.0%
500-year	0.2%

FEMA's Map Service Center website provides access to currently available FEMA floodplain mapping and flood insurance studies.

FEMA recently completed a significant map modernization effort that updated and converted the paper FIRMs into a digital format for mapping the nation's highest-risk areas. FEMA Region III began this effort in 2003. All mapped jurisdictions in Virginia now have DFIRMs, which were obtained from FEMA's National Flood Hazard Layer (NFHL).

DCR, in collaboration with VIMS, has developed the Virginia Flood Risk Information System (VFRIS), an online tool that allows users to view and assess flood risk and help communities plan for resiliency. VFRIS includes all SFHAs in Virginia (taken from FEMA's NFHL), flood

depth grids, the Limit of Moderate Wave Action, parcel boundaries, the ability to download flood insurance studies and flood risk reports, among other things.

The next phase of map modernization is underway. This strategy is named Risk MAP (Risk Mapping, Assessment, and Planning) and will enable FEMA to improve, maintain, and expand the flood hazard identification while leveraging more benefits and community action from updated NFIP maps. As part of the Risk MAP effort, the coastal areas of Virginia were updated with new and updated FIRMs and FIS products, including non-regulatory products, to assist with mitigation activities in these flood-prone areas.

The Virginia Department of Conservation and Recreation (DCR) serves as the coordinator of all flood protection programs and activities in the Commonwealth (Va. Code §10.1-602), including acting as a liaison between FEMA and local communities to promote compliance with the NFIP. Currently, 290 of the 323 communities in the Commonwealth participate in the NFIP. Additionally, 25 communities are participating in the Community Rating System, resulting in a total statewide savings of more than $4.8 million.

Over $690 million has been paid to NFIP-insured properties in the Commonwealth (from 1978 through 2016). Table 3.10-3 shows the total amount paid in insurance claims since 1978 for all insured properties as well as the number of policies, organized by participating community. All values for incorporated towns are included within the county.

Repetitive Loss Properties

A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten-year period, since 1978. There are 6,564 RL properties in the Commonwealth as of December 2016.

Over $317 million has been paid on the current list of non-mitigated repetitive loss properties in the Commonwealth (though December 2016). Communities with over $1 million paid on non-mitigated repetitive loss properties are included in Table 3.10-4. Urbanized jurisdictions on the coast of Virginia experienced a large increase in the number of repetitive loss properties from 2008 to 2011, these include Poquoson, Hampton, Norfolk, Virginia Beach, York County, Chesapeake, and Portsmouth. While not quite as dramatic, this trend continues to the present day.

Local Plan Comparison

Each of the 20 local plans discussed repetitive loss properties in their hazard mitigation plan. Each plan also includes mitigation strategy actions to address repetitive loss properties and NFIP compliance.

Table 3.10-3 : NFIP Policies and Claims Paid (1978-2016)

Jurisdiction	Number of Policies	Total Number of Claims Since 1978	Total Paid Since 1978
Accomack County	3,372	1,087	$12,083,531
Albemarle County	323	125	$1,217,653
Alexandria, City of	1,602	266	$3,762,441
Alleghany County	216	230	$3,264,843
Amelia County	5	12	$133,856
Amherst County	39	83	$1,359,511
Appomattox County	9	9	$256,136
Arlington County	987	130	$372,316
Augusta County	289	176	$2,002,382
Bath County	40	17	$177,105
Bedford, City of	4	0	$0
Bedford County	118	29	$224,125
Bland County	58	56	$726,016
Botetourt County	241	295	$4,478,570
Bristol, City of	63	15	$71,753
Brunswick County	20	11	$27,361
Buchanan County	220	365	$3,052,415
Buckingham County	12	11	$25,510
Buena Vista, City of	51	259	$4,371,143
Campbell County	42	23	$667,058
Caroline County	86	4	$22,208
Carroll County	17	16	$136,910
Charles City County	20	7	$42,606
Charlotte County	0	1	$1,709
Charlottesville, City of	108	39	$295,875
Chesapeake, City of	7,995	2,497	$25,728,077
Chesterfield County	849	180	$2,591,284
Clarke County	72	39	$759,060
Colonial Heights, City of	108	79	$1,061,118
Covington, City of	129	206	$1,756,391
Craig County	64	98	$1,333,068
Culpeper County	90	28	$439,853
Cumberland County	45	43	$398,008
Danville, City of	95	71	$843,102
Dickenson County	54	114	$448,042
Dinwiddie County	41	2	$11,979
Emporia, City of	38	11	$6,061
Essex County	277	257	$6,395,353
Fairfax, City of	607	50	$888,560

Jurisdiction	Number of Policies	Total Number of Claims Since 1978	Total Paid Since 1978
Fairfax County	7,111	1,045	$10,882,354
Falls Church, City of	258	45	$399,413
Fauquier County	206	14	$98,836
Floyd County	20	21	$751,569
Fluvanna County	36	22	$254,814
Franklin, City of	131	102	$5,433,141
Franklin County	139	31	$654,187
Frederick County	144	49	$386,136
Fredericksburg, City of	179	35	$137,399
Galax, City of	0	2	$3,227
Giles County	129	65	$1,047,516
Gloucester County	1,525	1,358	$30,480,407
Goochland County	50	12	$137,265
Grayson County	31	6	$14,563
Greene County	35	19	$71,500
Greensville County	15	4	$26,145
Halifax County	32	199	$1,126,570
Hampton, City of	10,760	5,681	$73,650,142
Hanover County	213	26	$258,261
Harrisonburg, City of	195	24	$94,643
Henrico County	961	242	$2,994,920
Henry County	102	200	$2,359,271
Highland County	24	7	$59,447
Hopewell, City of	29	13	$123,490
Isle of Wight County	413	177	$4,937,705
James City County	921	345	$6,251,357
King and Queen County	54	22	$584,114
King George County	82	7	$46,101
King William County	101	84	$2,324,132
Lancaster County	604	391	$5,988,721
Lee County	71	72	$795,078
Lexington, City of	14	37	$407,205
Loudoun County	845	138	$1,853,333
Louisa County	61	3	$3,127
Lunenburg County	2	0	$0
Lynchburg, City of	94	123	$3,247,934
Madison County	35	18	$120,437
Manassas, City of	81	30	$215,536
Manassas Park, City of	20	7	$94,804
Mathews County	1,479	1,198	$20,890,494

Jurisdiction	Number of Policies	Total Number of Claims Since 1978	Total Paid Since 1978
Mecklenburg County	49	4	$7,036
Middlesex County	437	242	$3,232,849
Montgomery County	209	153	$1,151,377
Nelson County	95	35	$239,775
New Kent County	114	29	$488,862
Newport News, City of	2,042	995	$22,770,431
Norfolk, City of	11,896	5,834	$65,126,389
Northampton County	476	104	$1,129,836
Northumberland County	739	391	$6,934,261
Norton, City of	39	18	$94,604
Nottoway County	1	1	$1,408
Orange County	54	14	$113,194
Page County	206	181	$3,455,458
Patrick County	21	43	$1,063,383
Petersburg, City of	131	80	$584,619
Pittsylvania County	23	35	$549,939
Poquoson, City of	3,215	4,184	$71,587,682
Portsmouth, City of	3,958	1,652	$16,044,771
Powhatan County	28	1	$4,867
Prince Edward County	4	0	$0
Prince George County	88	28	$233,738
Prince William County	1,373	382	$4,853,063
Pulaski County	109	64	$645,070
Radford, City of	27	2	$21,414
Rappahannock County	37	2	$4,168
Richmond, City of	563	515	$10,666,886
Richmond County	84	84	$1,764,534
Roanoke, City of	622	1,119	$19,644,719
Roanoke County	444	521	$5,042,698
Rockbridge County	183	358	$5,413,345
Rockingham County	471	307	$4,471,909
Russell County	79	61	$391,828
Salem, City of	440	712	$16,194,727
Scott County	73	33	$441,283
Shenandoah County	206	219	$6,122,701
Smyth County	158	159	$1,235,433
Southampton County	145	80	$2,887,606
Spotsylvania County	307	27	$78,010
Stafford County	628	115	$844,125
Staunton, City of	143	29	$300,589

Jurisdiction	Number of Policies	Total Number of Claims Since 1978	Total Paid Since 1978
Suffolk, City of	876	216	$3,854,736
Surry County	46	78	$2,446,309
Sussex County	47	35	$143,669
Tazewell County	316	417	$4,060,399
Virginia Beach, City of	22,310	5,939	$86,073,019
Warren County	286	428	$8,147,403
Washington County	155	64	$658,734
Waynesboro, City of	161	353	$6,139,705
Westmoreland County	516	212	$6,324,005
Williamsburg, City of	42	20	$148,368
Winchester, City of	174	8	$29,909
Wise County	328	358	$2,170,056
Wythe County	90	16	$101,549
York County	3,057	1,556	$33,950,975
Totals:	**103,929**	**47,328**	**$690,950,975**

Table 3.10-4: Repetitive Loss – NFIP Claims +$1M Paid on Unmitigated Structures (1978-2016)

Jurisdiction	Repetitive Loss Claims > $1 Million
Accomack County	$1,454,359.03
Alexandria, City of	$1,871,286.89
Buchanan, Town of	$1,189,972.47
Buena Vista, City of	$1,929,563.46
Chesapeake, City of	$18,985,968.99
Colonial Beach, Town of	$1,060,151.70
Essex County	$1,510,001.33
Fairfax County	$3,395,839.21
Gloucester County	$6,606,351.86
Hampton, City of	$44,228,294.79
Henrico County	$1,627,858.76
Isle of Wight County	$1,215,869.69
James City County	$2,092,250.11
Lancaster County	$3,726,596.70
Lynchburg, City of	$2,015,828.99
Mathews County	$7,598,090.17
Middlesex County	$1,022,317.10
Newport News, City of	$15,873,098.51
Norfolk, City of	$47,400,103.25
Northumberland County	$3,969,491.26
Poquoson, City of	$36,947,978.80

Jurisdiction	Repetitive Loss Claims > $1 Million
Portsmouth, City of	$9,979,707.78
Prince William County	$1,318,834.75
Richmond, City of	$6,776,795.12
Richmond County	$1,334,258.06
Roanoke, City of	$6,730,741.99
Rockbridge County	$1,538,643.99
Rockingham County	$1,580,684.50
Salem, City of	$13,579,069.88
Shenandoah County	$3,530,697.82
Suffolk, City of	$2,511,966.07
Tazewell County	$1,059,865.94
Virginia Beach, City of	$36,602,414.38
Warren County	$3,980,849.50
Waynesboro, City of	$4,998,238.11
Westmoreland County	$1,356,494.58
York County	$15,383,810.94
Total:	**$317,984,326**

Severe Repetitive Loss Properties

A Severe Repetitive Loss (SRL) property has at least four NFIP claim payments over $5,000 each (building and contents); or at least two separate claims payments with the cumulative amount exceeding the market value of the building. Table 3.10-5 shows non-mitigated severe repetitive loss structures by participating community, and the amount of the claims paid on them (more than $1 million). Norfolk, Hampton, Chesapeake, and Virginia Beach have all seen increases in the number of severe repetitive loss structures from 2008 to the present day.

Table 3.10-5: Severe Repetitive Loss – NFIP Claims +$1M Paid on Unmitigated Structures (1978-2016)

Jurisdiction	SRL Claims > $1 Million
Chesapeake, City of	$3,482,367.46
Gloucester County	$1,153,751.71
Hampton, City of	$7,755,132.21
Mathews County	$1,256,004.23
Norfolk, City of	$11,470,030.88
Poquoson, City of	$3,286,648.14
Portsmouth, City of	$1,841,472.91
Salem, City of	$10,063,589.31
Virginia Beach, City of	$11,101,694.00
York County	$1,431,911.36
Total:	**$52,842,602**

Additional Resources to Evaluate Flooding

The National Weather Service (NWS) Advanced Hydrologic Prediction System (AHPS) provides detailed information on recent water level trends, as well as forecasts for several gauges (both inland and coastal) across the Commonwealth. More than 1,000 gauges in Virginia are available for observation, as is their status (major flooding, no flooding, at or below low water threshold, out of service, etc.). An advantage to this product is the ability to visualize the gauge's status relative to established flood levels (active, minor, moderate, and major). Figures 3.10-1 and 3.10-2 provide examples of the products available.

Figure 3.10-1: James River at Richmond-Westham

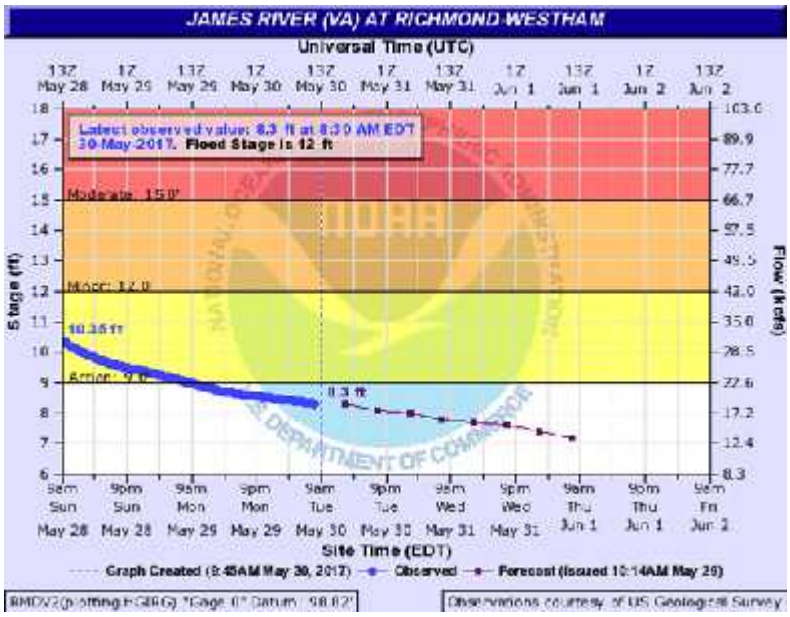
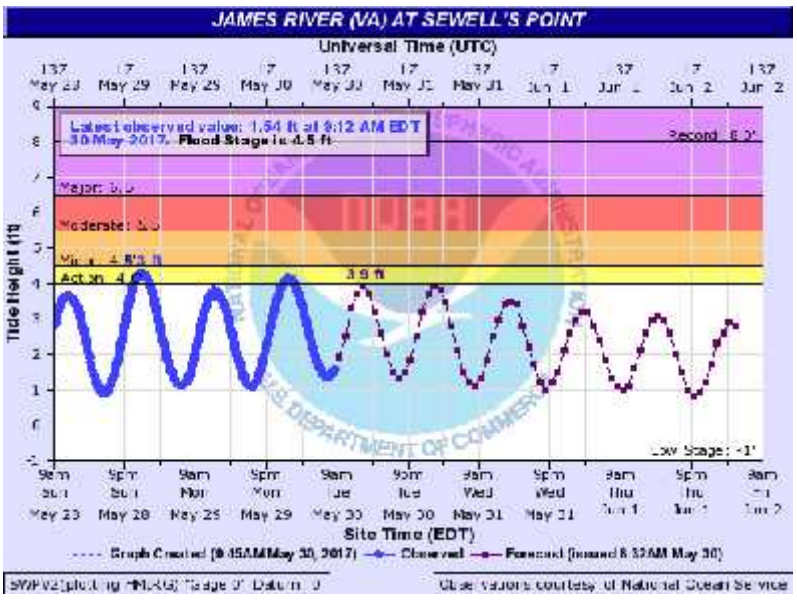


Figure 3.10-2: James River at Sewell's Point



The NOAA Office for Coastal Management has a sea level rise viewer that is a web based mapping tool to visualize community level impacts from coastal flooding or sea level rise (up to six feet above average high tides). The tool provides data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration, as well as photo simulations on how future flooding might impact local landmarks.[10]

AdaptVA has an online tool which uses an interactive map to view water levels, social vulnerability, infrastructure, and natural capital. A community's risk can be adjusted to low, intermediate, and extreme, and also indicates flood zones.[11]

Risk Assessment

Probability

Flooding probability is in terms of designated zones on FIRMs. Table 3.10-6 describes the different flood hazard areas and their associated probabilities.

Table 3.10-6: FEMA Special Flood Hazard Area Designations and Probabilities

Flood Zone	Description
A	1% annual chance of flood. No Base Flood Elevations determined.
AE	1% annual chance of flood. Base Flood Elevations determined.
AH	Subject to 1% annual chance shallow flooding with flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
AO	Subject to 1% annual chance shallow flooding with flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); Base Flood Elevations undetermined.
V	Subject to 1% annual chance flood. Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
VE	Subject to 1% annual chance flood. Coastal flood zone with velocity hazard (wave action); wave heights above 3 feet; Base Flood Elevations determined.
X	Areas with 0.2% annual chance of flood or less; areas in 1% annual chance flood zone with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
D	Areas in which flood hazards are undetermined, but possible.

Impact & Vulnerability

Populations and property are extremely vulnerable to flooding. Homes business, public buildings and critical infrastructure may suffer damage and be susceptible to collapse due to heavy flooding. Floodwaters can carry chemicals, sewage, and toxins from roads, factories, and farms; therefore, any property affected by the flood may be contaminated with

hazardous materials. Debris from vegetation and man-made structures may also be hazardous following the occurrence of a flood. In addition, floods may threaten water supplies and water quality, cause power outages, and create health concerns such as mold.

Risk

For some activities and facilities, even a slight chance of flooding is too great a threat. Typical critical facilities include hospitals, fire stations, police stations, storage of critical records, and similar facilities. These facilities should be given special consideration when formulating regulatory alternatives and floodplain management plans. A critical facility should not be in a floodplain, if possible. If a critical facility must be in a floodplain, it should be provided a higher level of protection so that it can continue to function and provide services after the flood. Communities should develop emergency plans to continue to provide these services during the flood.

Under Executive Order 11988, *Floodplain Management*, federal agencies funding and/or permitting critical facilities are required to avoid the 0.2 percent annual chance floodplain or protect the facilities to the 0.2 percent annual chance flood level[12].

To assess risks due to flooding, this plan used the FEMA flood zones to intersect state and critical facility locations to determine what flood zone the structure is in. Jurisdictional risk has been calculated in terms of annualized loss using certain assumptions borrowed from the FEMA benefit-cost analysis (BCA) modules.

State Facility Risk

Table 3.10-7a shows the state facilities located in FEMA flood zones from the 2013 plan.

Table 3.10-7a: State Facilities in FEMA Flood Zones 2013

Flood Zones	Number of State Facilities	Building Value*
VE	108	$8,681,870
AE	736	$632,811,032
A	579	$414,408,842
V	6	$471,005
X/500-year	166	$648,850,209
Total	1,595	$1,705,222,958

*Building values not available for all buildings

Table 3.10-7b shows the state facilities located in FEMA flood zones for this plan update. The changes are due to the dataset available during the plan update process. Mitigation actions should address data limitations and consistency in a buildable dataset. Due to uncertainty in many of the state facility locations (from the Virginia Agency Property

System, *VAPS*, database), it is difficult to conclusively determine the potential risk to state facilities. Based on the current datasets, only a conservative estimate is possible. By intersecting the current VAPS spatial locations (individual building footprints, building groups, and geocoded points) with the digital flood mapping data, the number of buildings was determined, shown in Table 3.10-7b. In cases where a building footprint, building group polygon, or geocoded point intersected multiple flood zones, the building was assigned to the more severe flood zone. Therefore, it is more appropriate to describe the results of this analysis as showing the proximity to the floodplain, rather than a specific determination of a building's flood zone status. In addition, Figures 3.10-3 through 3.10-9 show the location of these assets in relation to the identified SFHA.

Table 3.10-7b: State Facilities in FEMA SFHAs, by VDEM Region 2017

Flood Zones	VDEM Region 1	VDEM Region 2	VDEM Region 3	VDEM Region 4	VDEM Region 5	VDEM Region 6	VDEM Region 7
A	19	10	1	109	10	13	33
AE	288	7	19	77	136	49	10
AH/AO	0	0	0	0	1	0	0
VE	0	0	0	0	0	0	0
X / 500-year	21	0	2	0	58	5	2
Total	**321**	**17**	**22**	**208**	**205**	**67**	**45**

As shown in Table 3.10-7, 885 state facilities are within an identified floodplain. However, focusing just on the subset of state facilities for which individual building footprints were processed, it is possible to more closely target specific facilities for mitigation activities. An analysis of these buildings revealed 797 buildings in a 1% annual chance floodplain, and 88 buildings in a .2% annual chance floodplain.

Of the individual building footprints identified in 1% annual chance floodplain, state agencies, such as the Department of Transportation, also have more facilities in the floodplain than others, as seen in Table 3.10-8.

Table 3.10-8: Agencies with Multiple Building Footprints Identified in SFHA

Agency	Number of Buildings
Virginia Department of Transportation	92
Virginia Department of Forestry	22
Virginia Department of Corrections	448
Virginia Department of Game and Inland Fisheries	33

Virginia Department of Conservation and Recreation	118

Figure 3.10-3: State Facilities in SFHA – VDEM Region 1

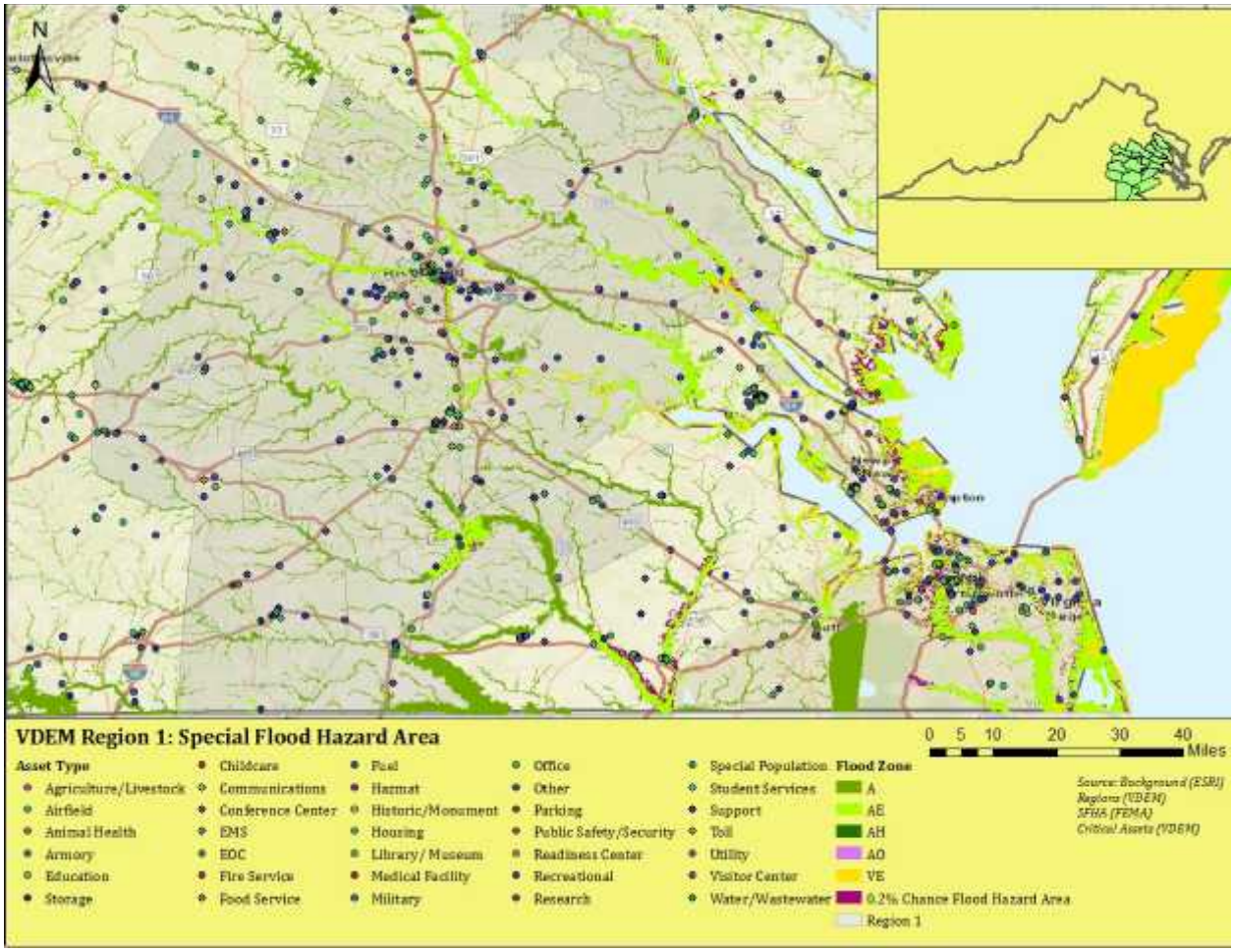


Figure 3.10-4: State Facilities in SFHA – VDEM Region 2

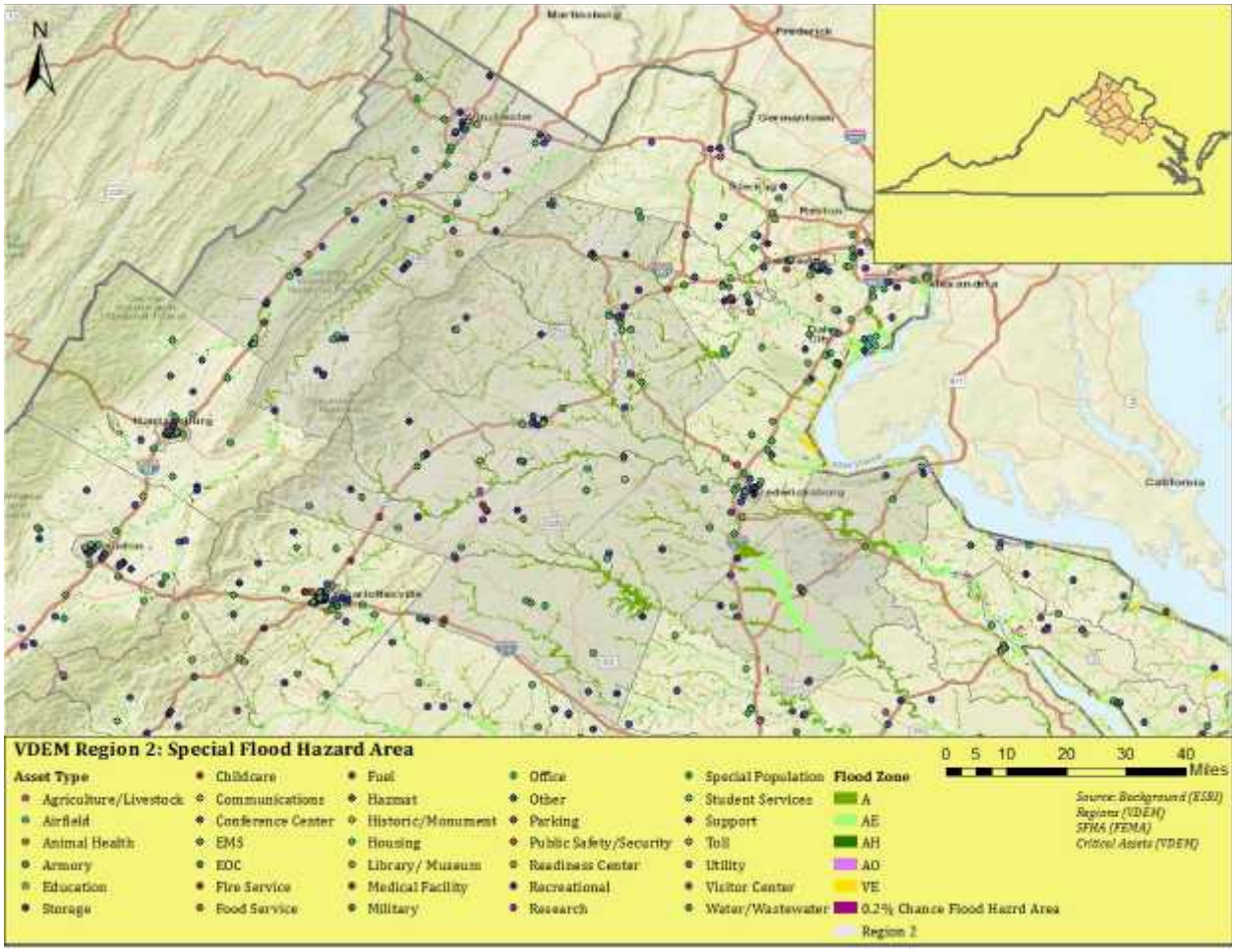


Figure 3.10-5: State Facilities in SFHA – VDEM Region 3

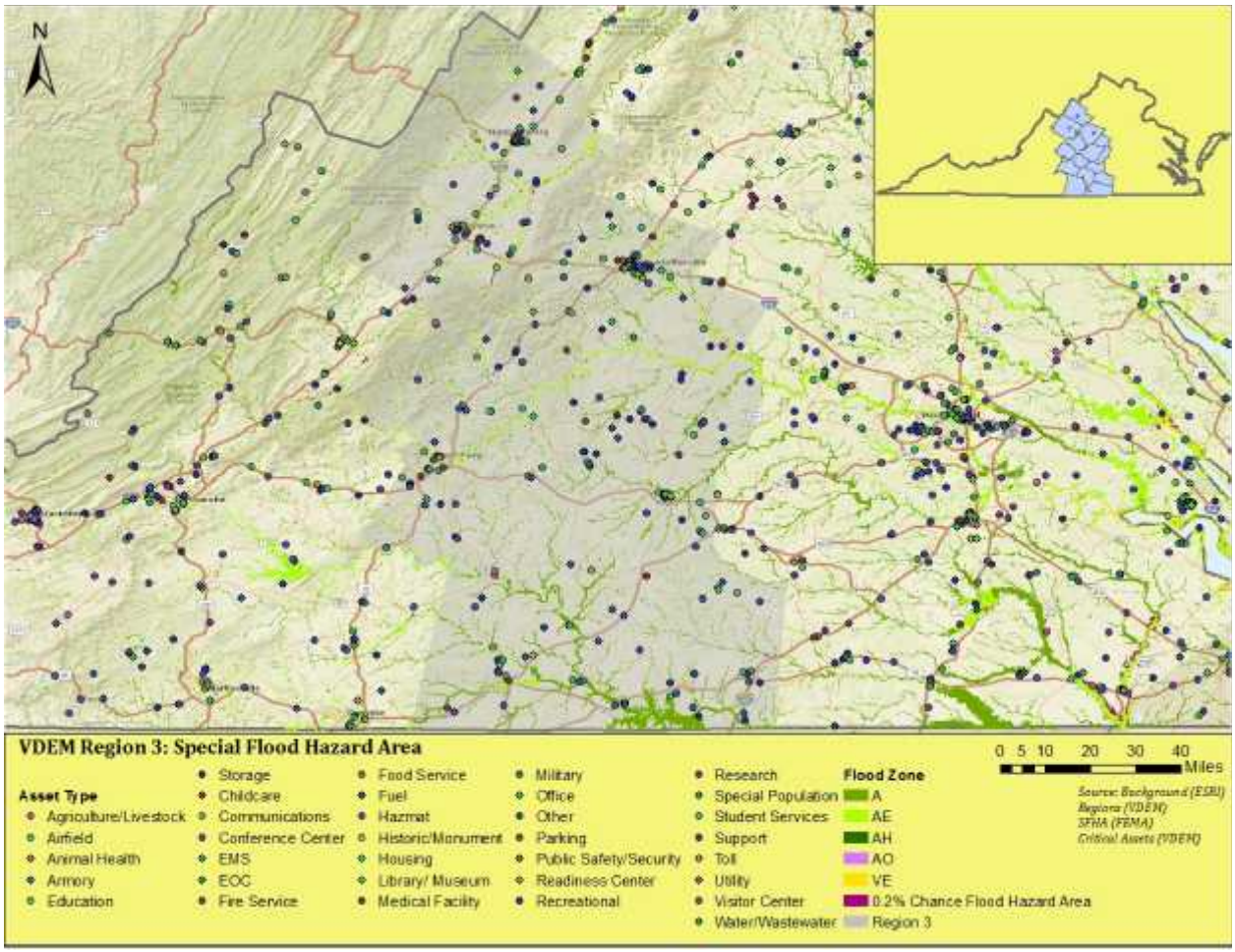


Figure 3.10-6: State Facilities in SFHA – VDEM Region 4

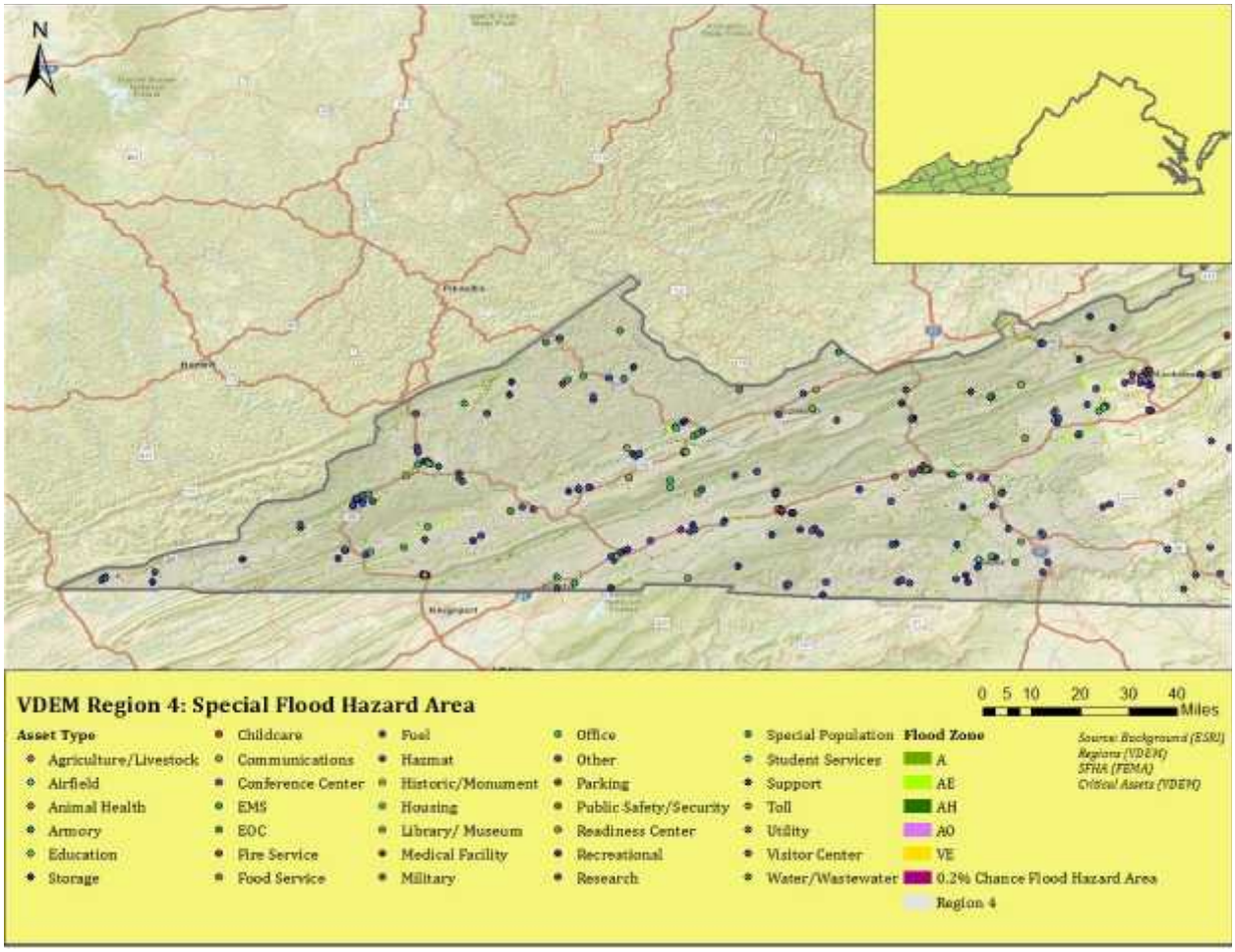


Figure 3.10-7: State Facilities in SFHA – VDEM Region 5

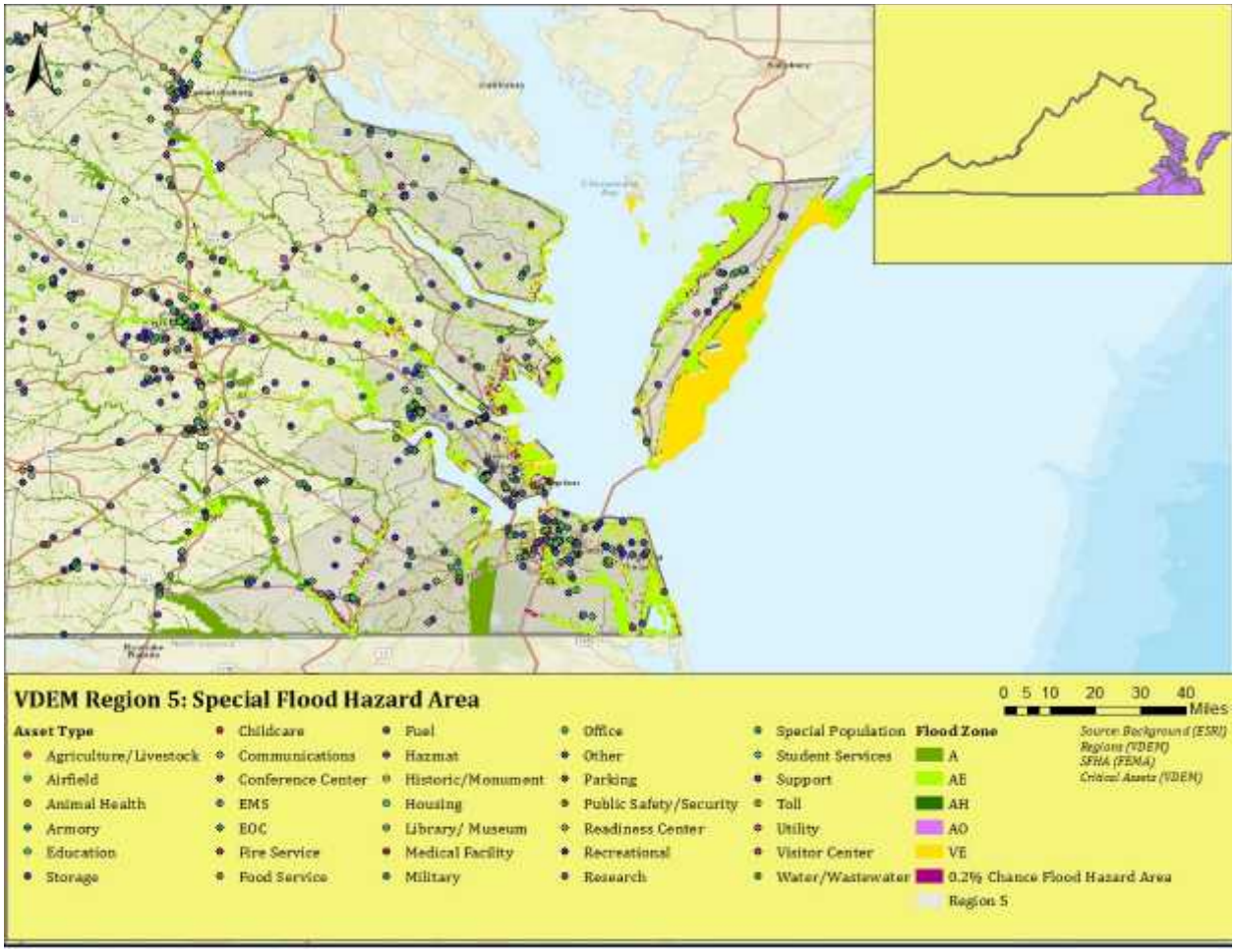


Figure 3.10-8: State Facilities in SFHA – VDEM Region 6

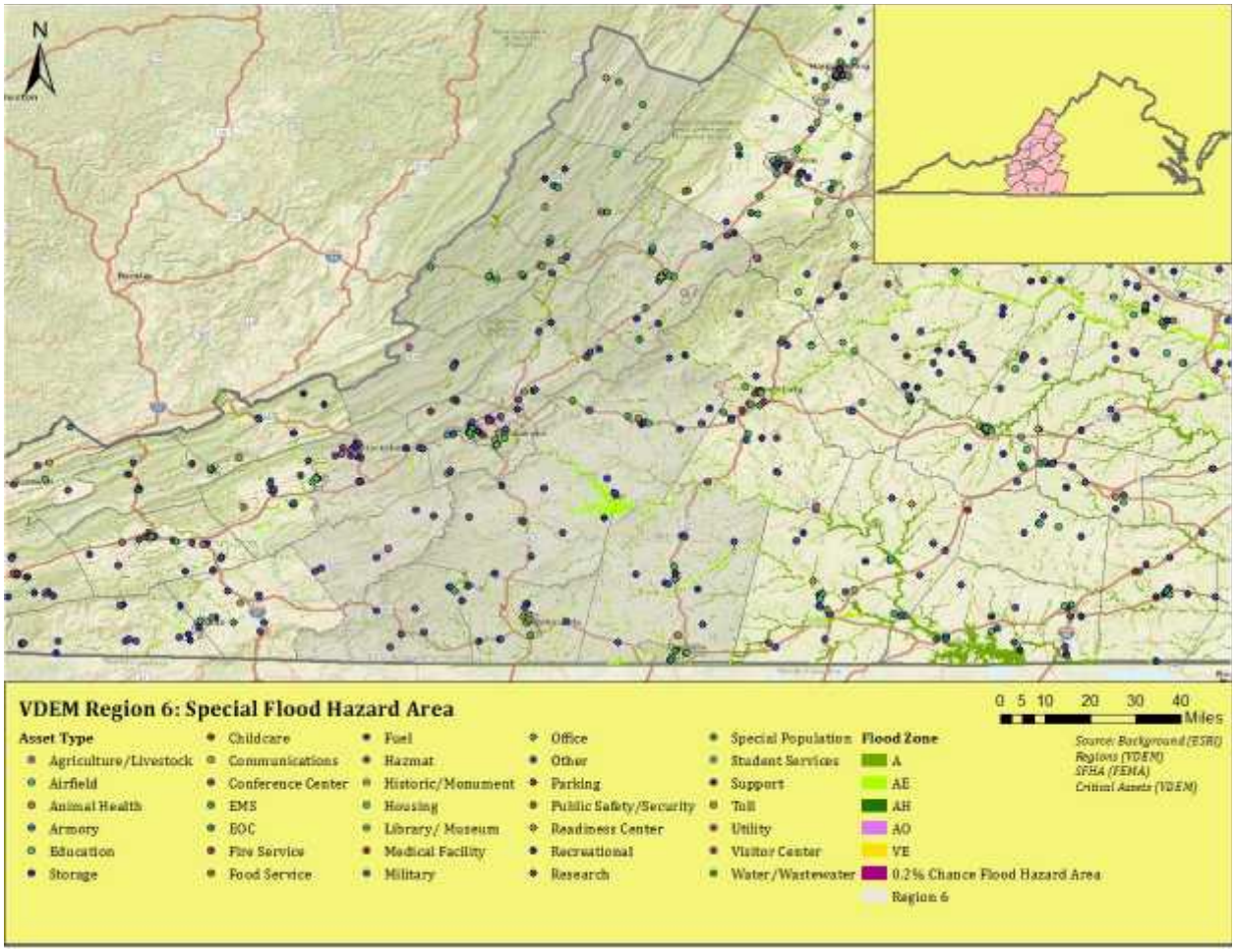
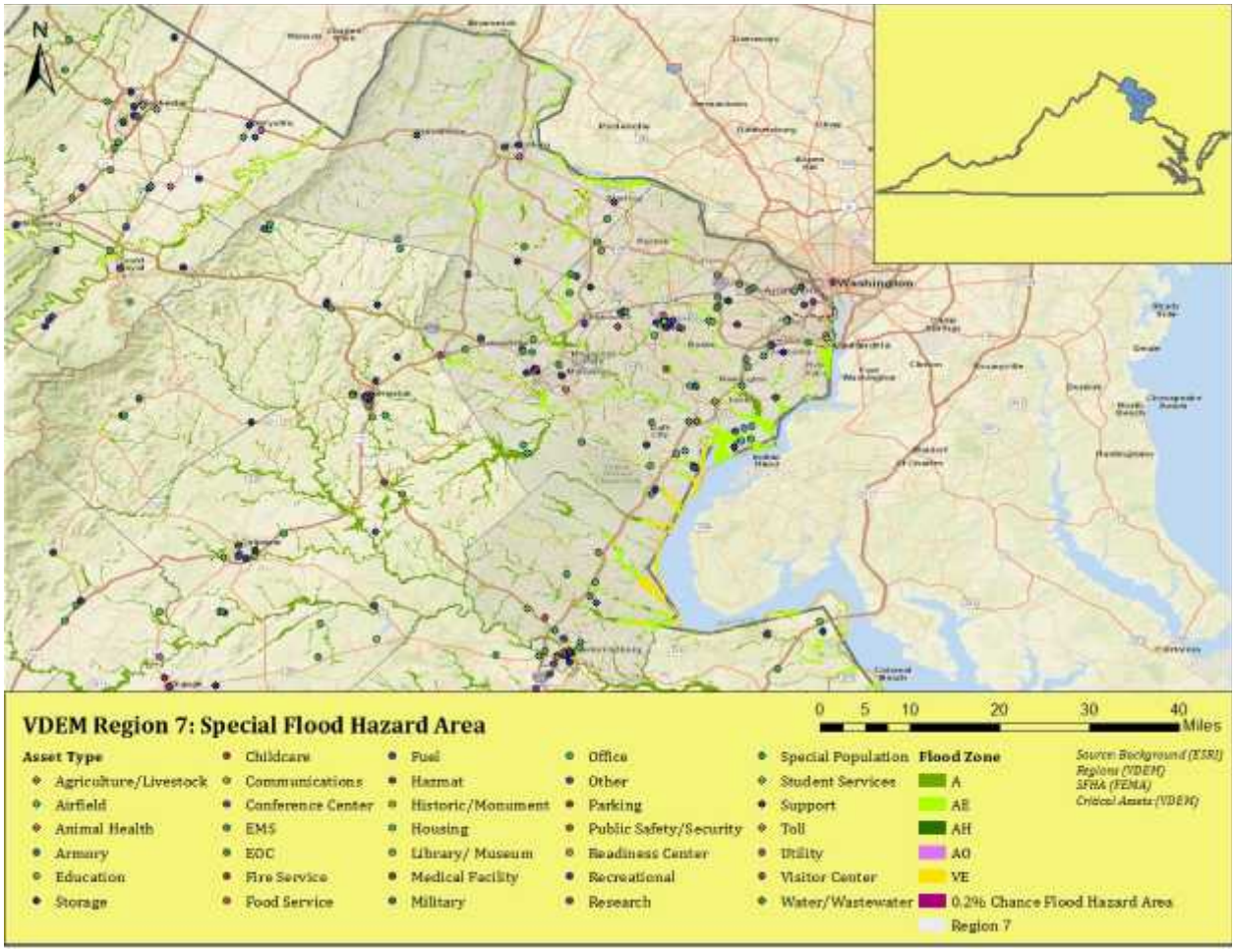


Figure 3.10-9: State Facilities in SFHA – VDEM Region 7



Critical Facility Risk

Critical facility point locations were intersected with the FEMA SFHAs to determine what flood zone the facility was in. This simplified approach, as compared to the VAPS state facility analysis, is a result of having limited spatial and attribute data for critical facilities. Loss estimations were not calculated for critical facilities; with better location and attribute information this could be completed for state and critical facilities. Mitigation actions should address these data limitations.

As shown in Table 3.10-9, a limited number of critical facilities are in FEMA designated SFHA. Approximately 155 critical facilities (1.2% of all state facilities) are in a mapped SFHA. Utilities have the highest number of facilities in the floodplain.

Table 3.10-9: Critical Facilities in FEMA-Identified Flood Zones 2017

Flood Zones	Haz Mat	Comm or Armory	Animal Health or Research	Utility	Food Service/ Storage	Fuel Storage / Distribution	Medical	Public Safety / Security	Special Population
A	2	2	2	21	3	5	2	16	1
AE	12	4	3	22	4	16	4	19	2
AH / AO	0	0	1	0	0	0	0	0	0
VE	0	0	0	0	0	0	0	0	0
X	2	1	1	5	0	4	0	1	0
V / VE	0	0	0	0	0	0	0	0	0
Total	**16**	**7**	**7**	**48**	**7**	**25**	**6**	**36**	**3**

Comparison with Local Plan Critical Facility Risk

Each local plan provided some type of numerical analysis on critical facilities located within the SFHA; in total, these plans identified approximately 500 critical (or essential) facilities in a floodplain. The analysis methods used in the local plans vary by locality and data available for analysis. Some used existing data from storm water management plans and floodplain management plans, visual inspection of structures in the floodplain, and others used GIS to intersect building information with FEMA FIRMs. Without a standardized analysis method, the local plan results cannot be truthfully compared to each other or the statewide analysis.

As discussed in section 3.4, many of the local plans did not provide spatial data for their critical facilities. There is currently no standardized definition of what constitutes a critical facility, and the resolution of this issue should continue to be a mitigation action in this revision to ensure that future updates will be able to use standardized, locally created, and maintained data.

Flood Risk to Energy Pipelines

Transmission pipelines and supporting infrastructure are vulnerable to damage during flood events. Increased stream flow rates during flood events can erode banks at places where pipelines cross streams, potentially undermining the structural supports of the pipeline, and causing the pipeline to sag or break. Flood waters that inundate pipelines may also be carrying debris or watercraft which can impact the pipeline, resulting in damage. Exposed pipelines inundated by flood waters may be damaged by floating debris, which can result in material being discharged into the environment creating a water quality or public health issue. Damage to pipelines could result in spillage of the pipeline's contents, potentially resulting in environmental and human health impacts. Damage to pipelines, or even precautionary measures to minimize potential damage, could halt normal pipeline

operations. This could include the loss of critical energy supplies to the regions impacted by the same flooding event, thereby complicating response and recovery activities.

Future Conditions Considerations

Changes in climate increase the probability of some types of weather. Recent trends in heavy rains are consistent with increasing temperatures; such occurrences are expected to become more frequent over time. As temperatures increase, more rain has fallen during heavy rain events. Very heavy precipitation events – the heaviest one percent of heavy rain events – now drop 67 percent more rain in the Northeast and 31 percent more in the Midwest than they did 50 years ago. This happens because warmer air holds more moisture than cooler air. This phenomenon is observable at an ordinary level; it is evident when water vapor (steam) hangs in the air after a hot shower. When the warm air holding the vapor meets cooler air, the moisture condenses into tiny droplets. If the droplets become large and heavy enough, they fall as precipitation – rain.

Recent climate studies show that rain events are becoming more frequent, with increasing rainfall amounts occurring in shorter periods of time. Warm air has the capacity to hold more water than cold air, and if the current trend of rising temperature continues, then this increases the probability and frequency of future heavy rainfall events. As a result, areas that already experience flooding are likely to experience more frequent flooding, and areas that have been historically less susceptible to flooding will face an increased risk.

If temperatures continue to increase as they have in the previous decades, the expectation is that the amount of rainfall that will fall during the heaviest rain events will increase more than 40 percent by the end of the century. Even best case scenarios still result in a 20 percent increase. This means that areas that are currently vulnerable to heavy precipitation – and flooding – will see an increase in the frequency and severity of their heavy precipitation and flooding events[13].

Jurisdictional Risk

Annualized damages for flooding within each jurisdiction were calculated based on National Centers for Environmental Information (NCEI) crop and property damages; based on NCEI data, the Commonwealth can expect approximately **$13,536,633** in damages per year for flood related events. NCEI annualized damages have been calculated by taking the total damages per jurisdiction and dividing by the period of record (66 years). NCEI loss values are only based on reported past damages, regardless of if the structure is in a designated SFHA. The NCEI database cannot possibly track all instances of flooding, and there is some variability in the reporting. However, it remains the most complete data set available for use.

Table 3.10-10 provides the annualized loss from flooding for each jurisdiction, based on NCEI data. All values for incorporated towns are included within the county.

Table 3.10-10: Jurisdictional Annualized Losses from Flooding (1950-2016)

Jurisdiction Name	Property Damage	Crop Damage	Total Damages	Annualized Losses
Accomack	$ 13,375,000	$ -	$ 13,375,000	$ 202,651.52
Albemarle	$ 272,000	$ 900,000	$ 1,172,000	$ 17,757.58
Alexandria, City of	$ 718,000	$ -	$ 718,000	$ 10,878.79
Alleghany	$ 10,760,000	$ -	$ 10,760,000	$ 163,030.30
Amelia	$ 8,000	$ -	$ 8,000	$ 121.21
Amherst	$ 870,000	$ -	$ 870,000	$ 13,181.82
Appomattox	$ 1,120,000	$ 100,000	$ 1,220,000	$ 18,484.85
Arlington	$ 4,123,000	$ -	$ 4,123,000	$ 62,469.70
Augusta	$ 13,190,000	$ 2,100,000	$ 15,290,000	$ 231,666.67
Bath	$ 7,107,000	$ -	$ 7,107,000	$ 107,681.82
Bedford	$ 625,000	$ 155,000	$ 780,000	$ 11,818.18
Bedford, City of (former)	$ 10,000	$ -	$ 10,000	$ 151.52
Bland	$ 1,066,000	$ -	$ 1,066,000	$ 16,151.52
Botetourt	$ 3,050,000	$ -	$ 3,050,000	$ 46,212.12
Bristol, City of	$ 110,000	$ -	$ 110,000	$ 1,666.67
Brunswick	$ 300,000	$ -	$ 300,000	$ 4,545.45
Buchanan	$ 29,365,000	$ -	$ 29,365,000	$ 444,924.24
Buckingham	$ 615,500	$ -	$ 615,500	$ 9,325.76
Buena Vista, City of	$ 830,000	$ -	$ 830,000	$ 12,575.76
Campbell	$ 1,548,000	$ 520,000	$ 2,068,000	$ 31,333.33
Caroline	$ 122,000	$ -	$ 122,000	$ 1,848.48
Carroll	$ 2,428,000	$ -	$ 2,428,000	$ 36,787.88
Charles City, City of	$ -	$ -	$ -	$ -
Charlotte	$ 1,252,000	$ 320,000	$ 1,572,000	$ 23,818.18
Charlottesville, City of	$ 5,000	$ -	$ 5,000	$ 75.76
Chesapeake, City of	$ 21,235,000	$ 800,000	$ 22,035,000	$ 333,863.64
Chesterfield	$ 5,060,000	$ 50,000	$ 5,110,000	$ 77,424.24
Clarke	$ 2,534,000	$ 1,205,000	$ 3,739,000	$ 56,651.52
Colonial Heights, City of	$ 1,200,000	$ -	$ 1,200,000	$ 18,181.82
Covington, City of	$ 3,005,000	$ -	$ 3,005,000	$ 45,530.30
Craig	$ 230,000	$ 500	$ 230,500	$ 3,492.42
Culpeper	$ 683,000	$ 800,000	$ 1,483,000	$ 22,469.70
Cumberland	$ -	$ -	$ -	$ -
Danville, City of	$ 3,040,000	$ 1,200,000	$ 4,240,000	$ 64,242.42
Dickensen	$ 2,024,000	$ -	$ 2,024,000	$ 30,666.67
Dinwiddie	$ 2,901,000	$ 420,000	$ 3,321,000	$ 50,318.18

Jurisdiction Name	Property Damage	Crop Damage	Total Damages	Annualized Losses
Emporia	$ 405,000	$ 55,000	$ 460,000	$ 6,969.70
Essex	$ 1,695,000	$ 20,000	$ 1,715,000	$ 25,984.85
Fairfax	$ 14,104,000	$ 26,000	$ 14,130,000	$ 214,090.91
Fairfax, City of	$ 2,506,000	$ -	$ 2,506,000	$ 37,969.70
Falls Church, City of	$ 620,000	$ -	$ 620,000	$ 9,393.94
Fauquier	$ 3,233,000	$ 20,000	$ 3,253,000	$ 49,287.88
Floyd	$ 3,568,000	$ -	$ 3,568,000	$ 54,060.61
Fluvanna	$ -	$ -	$ -	$ -
Franklin	$ 1,134,000	$ 100,000	$ 1,234,000	$ 18,696.97
Franklin, City of	$ 4,453,000	$ 700,000	$ 5,153,000	$ 78,075.76
Frederick	$ 2,623,000	$ 250,000	$ 2,873,000	$ 43,530.30
Fredericksburg, City of	$ 110,000	$ -	$ 110,000	$ 1,666.67
Galax, City of	$ 74,000	$ -	$ 74,000	$ 1,121.21
Giles	$ 5,386,000	$ -	$ 5,386,000	$ 81,606.06
Gloucester	$ 2,203,000	$ 750,000	$ 2,953,000	$ 44,742.42
Goochland	$ -	$ -	$ -	$ -
Grayson	$ 682,000	$ -	$ 682,000	$ 10,333.33
Greene	$ 435,500	$ 80,000	$ 515,500	$ 7,810.61
Greensville	$ 1,650,000	$ 800,000	$ 2,450,000	$ 37,121.21
Halifax	$ 13,443,000	$ 5,220,000	$ 18,663,000	$ 282,772.73
Hampton, City of	$ 17,550,000	$ -	$ 17,550,000	$ 265,909.09
Hanover	$ 2,067,000	$ -	$ 2,067,000	$ 31,318.18
Harrisonburg, City of	$ 12,610,000	$ 8,054,000	$ 20,664,000	$ 313,090.91
Henrico	$ 2,605,000	$ -	$ 2,605,000	$ 39,469.70
Henry	$ 3,264,000	$ -	$ 3,264,000	$ 49,454.55
Highland	$ 1,185,000	$ 50,000	$ 1,235,000	$ 18,712.12
Hopewell, City of	$ -	$ -	$ -	$ -
Isle of Wight	$ 4,360,000	$ 4,580,000	$ 8,940,000	$ 135,454.55
James City	$ 605,000	$ 400,000	$ 1,005,000	$ 15,227.27
King and Queen	$ 617,000	$ -	$ 617,000	$ 9,348.48
King George	$ 257,500	$ -	$ 257,500	$ 3,901.52
King William	$ 1,257,000	$ -	$ 1,257,000	$ 19,045.45
Lancaster	$ 1,870,000	$ -	$ 1,870,000	$ 28,333.33
Lee	$ 1,103,000	$ -	$ 1,103,000	$ 16,712.12
Lexington, City of	$ 858,000	$ -	$ 858,000	$ 13,000.00
Loudoun	$ 2,138,000	$ 180,000	$ 2,318,000	$ 35,121.21
Louisa	$ -	$ -	$ -	$ -
Lunenburg	$ 50,000	$ -	$ 50,000	$ 757.58
Lynchburg, City of	$ 55,000	$ 20,000	$ 75,000	$ 1,136.36
Madison	$ 1,538,000	$ 2,750,000	$ 4,288,000	$ 64,969.70
Manassas, City of	$ 31,000	$ -	$ 31,000	$ 469.70

Jurisdiction Name	Property Damage	Crop Damage	Total Damages	Annualized Losses
Manassas Park, City of	$ 11,000	$ -	$ 11,000	$ 166.67
Martinsville, City of	$ 110,000	$ -	$ 110,000	$ 1,666.67
Mathews	$ 6,654,000	$ -	$ 6,654,000	$ 100,818.18
Mecklenburg	$ 178,000	$ -	$ 178,000	$ 2,696.97
Middlesex	$ 9,310,000	$ -	$ 9,310,000	$ 141,060.61
Montgomery	$ 2,181,000	$ 5,000	$ 2,186,000	$ 33,121.21
Nelson	$ 1,165,000	$ 50,000	$ 1,215,000	$ 18,409.09
New Kent	$ 653,000	$ -	$ 653,000	$ 9,893.94
Newport News, City of	$ 15,400,000	$ -	$ 15,400,000	$ 233,333.33
Norfolk, City of	$ 40,140,000	$ -	$ 40,140,000	$ 608,181.82
Northampton	$ 2,100,000	$ -	$ 2,100,000	$ 31,818.18
Northumberland	$ 20,430,000	$ -	$ 20,430,000	$ 309,545.45
Norton	$ 1,156,000	$ -	$ 1,156,000	$ 17,515.15
Nottoway	$ 18,000	$ -	$ 18,000	$ 272.73
Orange	$ 768,300	$ 1,050,000	$ 1,818,300	$ 27,550.00
Page	$ 8,716,000	$ 6,411,000	$ 15,127,000	$ 229,196.97
Patrick	$ 5,316,000	$ -	$ 5,316,000	$ 80,545.45
Petersburg, City of	$ 650,000	$ 200,000	$ 850,000	$ 12,878.79
Pittsylvania	$ 8,296,000	$ 2,957,000	$ 11,253,000	$ 170,500.00
Poquoson	$ 78,525,000	$ -	$ 78,525,000	$ 1,189,772.73
Portsmouth, City of	$ 24,120,000	$ -	$ 24,120,000	$ 365,454.55
Powhatan	$ -	$ -	$ -	$ -
Prince Edward	$ -	$ -	$ -	$ -
Prince George	$ 1,625,000	$ 1,100,000	$ 2,725,000	$ 41,287.88
Prince William	$ 776,000	$ 50,000	$ 826,000	$ 12,515.15
Pulaski	$ 230,000	$ -	$ 230,000	$ 3,484.85
Radford, City of	$ 750,000	$ -	$ 750,000	$ 11,363.64
Rappahannock	$ 892,500	$ 40,000	$ 932,500	$ 14,128.79
Richmond	$ 25,454,000	$ 200,000	$ 25,654,000	$ 388,696.97
Richmond, City of	$ 20,201,000	$ -	$ 20,201,000	$ 306,075.76
Roanoke	$ 3,464,000	$ -	$ 3,464,000	$ 52,484.85
Roanoke, City of	$ 4,248,000	$ -	$ 4,248,000	$ 64,363.64
Rockbridge	$ 6,318,000	$ -	$ 6,318,000	$ 95,727.27
Rockingham	$ 25,335,000	$ 10,554,000	$ 35,889,000	$ 543,772.73
Russell	$ 449,000	$ -	$ 449,000	$ 6,803.03
Salem, City of	$ 3,100,000	$ -	$ 3,100,000	$ 46,969.70
Scott	$ 264,000	$ -	$ 264,000	$ 4,000.00
Shenandoah	$ 52,806,000	$ 7,450,000	$ 60,256,000	$ 912,969.70
Smyth	$ 2,459,000	$ -	$ 2,459,000	$ 37,257.58
Southampton	$ 2,105,000	$ 500,000	$ 2,605,000	$ 39,469.70
Spotsylvania	$ 170,500	$ -	$ 170,500	$ 2,583.33

Jurisdiction Name	Property Damage	Crop Damage	Total Damages	Annualized Losses
Stafford	$ 408,000	$ -	$ 408,000	$ 6,181.82
Staunton, City of	$ 10,017,000	$ 1,600,000	$ 11,617,000	$ 176,015.15
Suffolk	$ 1,945,000	$ -	$ 1,945,000	$ 29,469.70
Surry	$ 1,460,000	$ 750,000	$ 2,210,000	$ 33,484.85
Sussex	$ 4,560,000	$ 1,050,000	$ 5,610,000	$ 85,000.00
Tazewell	$ 30,054,000	$ -	$ 30,054,000	$ 455,363.64
Virginia Beach, City of	$ 10,609,000	$ -	$ 10,609,000	$ 160,742.42
Warren	$ 49,837,000	$ 2,511,000	$ 52,348,000	$ 793,151.52
Washington	$ 336,000	$ -	$ 336,000	$ 5,090.91
Waynesboro, City of	$ 8,705,000	$ 1,600,000	$ 10,305,000	$ 156,136.36
Westmoreland	$ 415,000	$ 55,000	$ 470,000	$ 7,121.21
Williamsburg, City of	$ 55,000	$ -	$ 55,000	$ 833.33
Winchester, City of	$ -	$ -	$ -	$ -
Wise	$ 1,626,000	$ -	$ 1,626,000	$ 24,636.36
Wythe	$ 271,500	$ -	$ 271,500	$ 4,113.64
York	$ 78,690,000	$ -	$ 78,690,000	$ 1,192,272.73
Totals:	**$ 822,659,300**	**$ 70,758,500**	**$ 893,417,800**	**$ 13,536,633.33**

The appendix of this report compares flooding annualized loss and ranking to other hazards that impact Virginia. Flooding is considered the top hazard with regards to probability and impact to all jurisdictions in the Commonwealth.

Geographic extent for flooding was determined as the percent of the jurisdiction in a FEMA SFHA zone. Flood zone probabilities were not considered in the current ranking algorithm. The geographic extent parameter is based on the percent of the jurisdiction in the SFHA. The NCEI annualized crop and property damages were used to maintain consistency between the hazards. As discussed earlier, the NCEI annualized loss values are lower than what was calculated for the annualized loss. Section 3.5 of this chapter describes each of the parameters used in the ranking for each hazard. Table 3.10-11 describes the parameters used for calculating risk due to flooding. Most jurisdictions have been ranked as high. This is not surprising as flooding (riverine, coastal, and flash) is a major concern for most jurisdictions in the Commonwealth.

A previous version of this plan suggested including RL and/or SRL data as a special weighting factor in the ranking methodology. This plan does not do this, for two reasons. First, the jurisdictional flood analysis used in this plan, based on FEMA mapping and US Census demographics, is a uniform methodology that already accounts for the proximity of building values to mapped floodplains. Second, some of the RL and SRL properties may be experiencing flooding resulting from low-frequency events, improper drainage engineering, and/or egregiously poor building practices. While these problems are important, they are

highly local, and should be addressed at that level. The statewide jurisdictional risk assessment is intended to measure relative risks at a broader scale that can be compared equally, regardless of the level of RL or SRL reporting in each jurisdiction.

Table 3.10-11: Flood Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Medium-High	Low	High	Medium-High	Medium
Albemarle	Medium-High	Medium	Low	Medium-Low	Medium-High	High	Medium-Low	Medium
Alexandria, City of	Medium-High	High	Low	Medium-Low	Low	High	Medium-Low	Medium
Alleghany	Low	Low	Medium	Medium	Low	Medium	Medium-High	Medium-Low
Amelia	Low	Low	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Amherst	Medium	Medium	Low	Medium-Low	Low	Medium-High	Medium-Low	Medium-Low
Appomattox	Low	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Arlington	High	High	Medium-Low	Medium	Low	Medium-High	Medium	Medium
Augusta	Medium-High	Medium	Medium-Low	Medium-High	High	High	Medium-High	Medium-High
Bath	Low	Low	Low	Medium-High	Low	Medium	Medium-High	Medium-Low
Bedford	Medium-High	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium
Bland	Low	Low	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Botetourt	Medium	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Bristol, City of	Low	Medium-High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Brunswick	Medium	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Buchanan	Medium	Low	Medium-High	High	Low	High	High	Medium
Buckingham	Low	Low	Low	Medium-Low	Low	High	Medium-Low	Medium-Low
Buena Vista, City of	Low	Medium-High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Campbell	Medium	Medium	Low	Medium-Low	Medium	High	Medium-Low	Medium
Caroline	Medium	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Carroll	Medium	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium-Low
Charles City	Low	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Charlotte	Low	Low	Low	Medium-Low	Medium-Low	High	Medium-Low	Medium-Low
Charlottesville, City of	Medium	High	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Chesapeake, City of	High	Medium-High	Low	High	Medium-High	High	High	High
Chesterfield	High	Medium-High	Low	Medium	Low	Medium-High	Medium	Medium
Clarke	Low	Medium	Low	Medium-	High	High	Medium	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
				Low				
Colonial Heights, City of	Medium	High	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Covington, City of	Low	Medium-High	Low	Medium-Low	Low	Low	Medium-Low	Medium-Low
Craig	Low	Low	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Culpeper	Medium	Medium	Low	Medium-Low	Medium-High	High	Medium-Low	Medium
Cumberland	Low	Low	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Danville, City of	Medium	Medium-High	Low	Medium	High	High	Medium	Medium
Dickensen	Low	Low	Low	Medium-Low	Low	Medium-High	Medium-Low	Medium-Low
Dinwiddie	Medium	Low	Low	Medium	Medium-Low	Medium	Medium	Medium-Low
Emporia	Low	Medium-High	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Essex	Low	Low	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Fairfax	High	High	Medium-Low	Medium-High	Low	High	Medium-High	Medium-High
Fairfax, City of	Medium	High	High	Medium-Low	Low	Medium-High	Medium-Low	Medium
Falls Church, City of	Low	High	Low	Medium-Low	Low	Medium-High	Medium-Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Fauquier	Medium-High	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium
Floyd	Low	Low	Low	Medium	Low	Medium-Low	Medium	Medium-Low
Fluvanna	Medium	Medium	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Franklin	Medium	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium
Franklin, City of	Low	Medium-High	Low	Medium	Medium	Medium	Medium	Medium
Frederick	Medium-High	Medium	Medium-Low	Medium-Low	Low	High	Medium-Low	Medium
Fredericksburg, City of	Medium	High	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Galax, City of	Low	Medium-High	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Giles	Low	Low	Low	Medium	Low	High	Medium	Medium
Gloucester	Medium	Medium	Low	Medium-Low	Medium-High	Medium-High	Medium-Low	Medium
Goochland	Medium	Medium	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium
Grayson	Low	Low	Low	Medium-Low	Low	High	Medium-Low	Medium
Greene	Medium	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium
Greensville	Low	Low	Low	Medium-Low	Medium-High	Medium-Low	Medium-Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Halifax	Medium	Low	Low	High	High	High	High	Medium
Hampton, City of	Medium-High	High	Low	High	Low	High	High	Medium-High
Hanover	Medium-High	Medium	Medium-Low	Medium-Low	Low	Medium-High	Medium-Low	Medium
Harrisonburg, City of	Medium	High	Low	High	High	Medium	High	Medium-High
Henrico	High	Medium-High	Medium-Low	Medium-Low	Low	Medium-High	Medium-Low	Medium-Low
Henry	Medium	Medium	Medium-Low	Medium-Low	Low	High	Medium-Low	Medium
Highland	Low	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Hopewell, City of	Medium	High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Isle of Wight	Medium	Medium	Low	Medium-High	High	Medium-High	Medium-High	Medium
James City	Medium-High	Medium-High	Low	Medium-Low	Medium-Low	Medium	Medium-Low	Medium
King and Queen	Low	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
King George	Medium	Medium	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
King William	Low	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Lancaster	Low	Medium	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Lee	Medium	Low	Low	Medium-	Low	Medium-	Medium-Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
				Low		Low		
Lexington, City of	Low	High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Loudoun	High	Medium-High	Low	Medium	Low	High	Medium-Low	Medium
Louisa	Medium	Medium	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Lunenburg	Low	Low	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Lynchburg, City of	Low	Medium-High	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Madison	Low	Low	Low	Medium	High	High	Medium	Medium-Low
Manassas, City of	Medium	High	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Manassas Park, City of	Low	High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Martinsville, City of	Low	Medium-High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Mathews	Low	Medium	Low	Medium-High	Low	Medium-High	Medium-High	Medium
Mecklenburg	Medium	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Middlesex	Low	Medium	Low	Medium-High	Low	Medium	Medium-High	Medium-Low
Montgomery	Medium-High	Medium	Medium-Low	Medium-Low	Low	High	Medium-Low	Medium
Nelson	Low	Low	Low	Medium-	Low	High	Medium-Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
				Low				
New Kent	Low	Medium	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Newport News, City of	High	High	Low	Medium-High	Low	High	Medium-High	Medium-High
Norfolk, City of	High	High	Low	High	Low	High	High	Medium-High
Northampton	Low	Medium	Low	Medium-Low	Low	Medium	Medium-Low	Medium-Low
Northumberland	Low	Low	Low	High	Low	Medium	High	Medium-Low
Norton	Low	Medium-High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Nottoway	Low	Low	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Orange	Medium	Medium	Low	Medium-Low	High	High	Medium-Low	Medium
Page	Medium	Medium	Low	Medium-High	High	High	Medium-High	Medium-High
Patrick	Medium	Low	Low	Medium	High	High	Medium	medium
Petersburg, City of	Medium	Medium-High	Low	Medium-Low	Medium-Low	Medium	Medium-Low	Medium
Pittsylvania	Medium-High	Medium	Low	Medium-High	High	High	Medium-High	Medium-High
Poquoson	Low	Medium-High	Low	High	Low	Medium-Low	High	Medium
Portsmouth, City of	Medium-High	High	Low	High	Low	High	High	Medium-High
Powhatan	Medium	Medium	Low	Medium-	Low	Medium	Medium-Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
				Low				
Prince Edward	Medium	Medium	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium-Low
Prince George	Medium	Medium	Low	Medium-Low	High	Medium-High	Medium-Low	Medium
Prince William	High	Medium-High	Low	Medium-Low	Low	High	Medium-Low	Medium
Pulaski	Medium	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium
Radford, City of	Low	Medium-High	Low	Medium-Low	Low	Low	Medium-Low	Medium
Rappahannock	Low	Low	Low	Medium-Low	Low	High	Medium-Low	Medium
Richmond	Low	Low	Low	High	Low	Medium	High	Medium
Richmond, City of	High	High	Medium-Low	High	Low	Medium	High	Medium-High
Roanoke	Medium-High	Medium-High	Low	Medium	Low	High	Medium	Medium
Roanoke, City of	Medium-High	High	Low	Medium	Low	High	Medium	Medium
Rockbridge	Medium	Low	Low	Medium	Low	High	Medium	Medium
Rockingham	Medium-High	Medium	Low	High	High	High	High	High
Russell	Medium	Low	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Salem, City of	Medium	High	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Scott	Medium	Low	Medium-Low	Medium-Low	Low	Medium	Medium-Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Shenandoah	Medium	Medium	Medium-High	High	High	High	High	High
Smyth	Medium	Medium	Low	Medium-Low	Low	Medium-High	Medium-Low	Medium
Southampton	Low	Low	Medium-Low	Medium-Low	Medium	Medium-High	Medium-Low	Medium
Spotsylvania	Medium-High	Medium	Low	Medium-Low	Low	Medium-High	Medium-Low	Medium
Stafford	Medium-High	Medium-High	Low	Medium-Low	Low	Medium-High	Medium-Low	Medium
Staunton, City of	Medium	Medium-High	Low	Medium	High	Medium	Medium-High	Medium
Suffolk	Medium-High	Medium	Low	Medium-Low	Low	Medium-High	Medium-Low	Medium
Surry	Low	Low	Low	Medium-Low	Medium-High	Medium-High	Medium-Low	Medium
Sussex	Low	Low	Low	Medium	High	Medium-High	Medium	Medium
Tazewell	Medium	Medium	Low	High	Low	High	High	Medium-High
Virginia Beach, City of	High	High	Low	Medium-High	Low	High	Medium-High	Medium-High
Warren	Medium	Medium	Medium-Low	High	High	High	High	High
Washington	Medium	Medium	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Waynesboro, City of	Medium	Medium-High	Medium-Low	Medium	High	Medium	Medium-High	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Westmoreland	Low	Medium	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium
Williamsburg, City of	Low	Medium-High	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Winchester, City of	Medium	High	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Wise	Medium	Medium	Low	Medium-Low	Low	Medium	Medium-Low	Medium
Wythe	Medium	Medium	Low	Medium-Low	Low	High	Medium-Low	Medium
York	Medium-High	Medium-High	Low	High	Low	High	High	Medium

For the 2018 update, the overall hazard ranking for flooding is high.

Local Plan Risk Assessment

Each of the 20 local plans were reviewed and summarized based on methodology and results for their flood analysis. Each plan varied based on the type of data available and analysis methodology. Techniques for assessing flood risk in the local plans included one or more of the following methods:

- FEMA HAZUS-MH
- NCEI statistics
- GIS intersections using FEMA FIRMs and Parcel/Census Data

11 local plans utilized HAZUS-MH to provide loss estimations. Six plans used GIS, largely through intersections of FEMA DFIRMs with parcel/census data to supplement their analysis, and three estimated losses from NCEI data.

As discussed in section 3.6 and above, local plan hazard analysis and loss estimations vary considerably. Table 3.10-12 and Figure 3.6-1 (section 3.6) shows the summary of the local plans that provided annualized flood losses. None of the annualized loss values for the local plans are the same as the values calculated for this revision. This is because the statewide plan developed a broad method to be able to calculate loss on the same scale for all the jurisdictions in the Commonwealth. For the most part, the statewide methodology results in conservative annualized loss estimates.

Table 3.10-12: Local Plan Annualized Losses - Flooding

Planning District Commission/Jurisdiction	Annualized Flood Loss
Accomack-Northampton (2012)	$2,788,820
Commonwealth Regional Council (2016)	$335,846
Central Shenandoah Valley (2013)	$3,681,938
Cumberland Plateau (2013)	$2,900,000
George Washington Regional Commission (2017)	$148,896,000
Hampton Roads (2017)	$14,690,196
LENOWISCO (2013)	No estimated losses provided
Middle Peninsula (2016)	$18,102,000
Mount Rogers (2011)	No estimated losses provided
New River Valley (2011)	$248,883
Northern Neck (20110	$6,625,524
Northern Shenandoah Valley (2012)	$6,857,556
Northern Virginia (2016)	$1,061,851,000
Rappahannock-Rapidan (2012)	$1,884,727
Region 2000 (2013)	$2,094,999

Planning District Commission/Jurisdiction	Annualized Flood Loss
Richmond-Crater (2011)	$6,474,812
Roanoke Valley-Alleghany (2013)	$3,635,903
Southside (2013)	$2,821,224,000
Thomas Jefferson (2012)	$1,400,000
West Piedmont (2016)	$8,628,034

No effort was made to determine differences due to data sources and loss calculations in the local plans. These factors can have a huge impact on how the results can be interpreted; this variation led to the decision to develop a statewide annualized loss calculation that has been fully described in the *Jurisdictional Risk* portion of this section.

16 local plans provided an estimate of the number of structures located within the SFHA; 16 plans provided an estimate of the structure value at risk (within the SFHA). Table 3.10-13 below provides a summary of the number and value of the structure at risk due to flooding from the local plan results. It should be noted that some plans only provided information for structures and facilities located within the one percent annual chance floodplain, while others provided information for the 1% annual chance and .2% annual chance floodplains, and some local plans did not report the number of buildings and building value within a SFHA. The total structure value at risk (buildings within an SFHA), from local plan analysis, was $10,186,947,112. For comparison, the total building value that lies within an SFHA used for the statewide annualized loss estimate was $65,646,246,000.

Table 3.10-13: Number and Value of Structures at Risk Due to Flooding

Jurisdiction	Structures at Risk	Structure Value at Risk
Accomack-Northampton (2012)	NA	NA
Central Shenandoah Valley (2013)	9,736	$1,149,173,500
Commonwealth Regional Council (2016)	NA	NA
Cumberland Plateau (2013)	6,045	$290,718,650
George Washington (2017)	113,370	$41,936,363,000
Hampton Roads (2017)	NA	NA
Lenowisco (2013)	5,427	$198,309,801
Middle Peninsula (2016)	43,501	$17,700,000,000
Mount Rogers (2011)	1,352	$123,003,282
New River Valley (2011)	N/A	N/A
Northern Neck (2011)	3,571	$465,807,800
Northern Shenandoah Valley (2012)	NA	$343,934,309
Northern Virginia (2016)	NA	NA
Rappahannock-Rapidan (2012)	10,141	$188,472,700
Region 2000 (2013)	NA	$346,443,566
Richmond-Crater (2011)	NA	NA

Jurisdiction	Structures at Risk	Structure Value at Risk
Roanoke Valley-Alleghany Region (2013)	NA	NA
Southside (2013)	25	$89,457,000
Thomas Jefferson (2012)	1,505	$188,858,478
West Piedmont (2016)	4,855	$8,628,034

Comparison with Local Ranking

18 of the 20 local hazard mitigation plans ranked flood as a high hazard; the remaining two ranked the hazard as medium.

The local plan ranking average for flood was high (section 3.6). The 2018 statewide analysis has ranked flood as high and is consistent with the local plans. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Local Plan Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). A few plans exclusively note that they prohibit construction in the floodplain. Development in the floodplain would drastically increase loss estimates.

Table 3.10-14: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impact expected to be severe to extensive for event areas and minor for other adversely affected areas.
Health and Safety of Response Personnel	Localized impacts expected to be limited unless the response personnel live within the impacted area, or the flood contains HAZMAT
Continuity of Operations	Damage to facilities/personnel around the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure around the event could be extensive.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impact expected to be severe for the event area due to erosion, crop damages, and HAZMAT and moderate to light damage to the outlying areas of the event.
Economic and Financial Condition	Local economy and finances adversely impacted, possibly for a prolonged period.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient. Local and state land development policies may be in question.

Endnotes

[1] Federal Emergency Management Agency. Disaster Declarations. Retrieved 04.06.17 from https://www.fema.gov/disasters?field_state_tid_selective=22&field_disaster_type_term_tid=All&field_disaster_declaration_type_value=All&items_per_page=60

[2] College of William and Mary, Virginia Institute of Marine Science, Initiative for Coastal Climate Change Research. *Planning for Sea Level Rise and Coastal Flooding.* Verified 04.06.17 from http://www.vims.edu/research/units/programs/icccr/_docs/coastal_sea_level.pdf

[3] Virginia Institute of Marine Science. Chesapeake Bay Land Subsidence and Sea Level Change. 2010

[4] USGS. Land Subsidence and Relative Sea Level Rise in the Southern Chesapeake Bay Region. 2013

[5] Ezer and Atkinson. Accelerated Flooding Along the U.S. East Coast: On the Impact of Sea Level Rise, Tides, Storms, the Gulf Stream, and the North Atlantic Oscillations. 2014.

[6] Virginia Department of Environmental Quality. *2012 305(b)/303(d) Water Quality Assessment Integrated Report, approved by EPA 12/12/13*. Verified on 04.06.17 from http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2012305(b)303(d)IntegratedReport.aspx

[7] Virginia Department of Emergency Management. *Integrated Flood Observing and Warning Systems – IFLOWS.* Verified 04.06.17 from http://www.vaemergency.gov/emergency-management-community/emergency-management-resources/integrated-flood-observing-and-warning-systems-iflows/

[9] Federal Emergency Management Agency. National Flood Insurance Program. Verified 04.06.17 from https://www.fema.gov/national-flood-insurance-program
[10] NOAA Office for Coastal Management Digitalcoast. Sea Level Rise Viewer. Retrieved 11.08.17 from https://coast.noaa.gov/digitalcoast/tools/slr
[11] AdaptVA. Evidence Based Planning for changing climate. Retrieved 11.08.17 from, http://www.adaptva.com/info/tools.html
[12] FEMA Critical Facilities and the NFIP. Verified 04.06.16 from http://www.fema.gov/national-flood-insurance-program-2/critical-facility
[13]The Union of Concerned Scientists. "Heavy Flooding and Global Warming: Is There a Connection?" Retrieved 05.06.17 from http://www.ucsusa.org/global_warming/science_and_impacts/impacts/heavy-flooding-and-global-warming.html#.WRY2D9y1ttQ

Section 3.11: Flooding Due to Impoundment Failure

Description

Flooding due to impoundment failure refers to a collapse, overtopping, breaching, or other failure that causes an uncontrolled release of water or sludge from an impoundment, resulting in downstream flooding. Dam or levee failures can occur with little warning. Intense storms may produce a flood in a few hours or even minutes from upstream locations. Flash floods can occur within six hours of the beginning of heavy rainfall, and impoundment failure may occur within hours of the first signs of breaching. Other failures and breeches can take much longer to occur, from days to weeks, because of debris jams or the accumulation of melting snow[1].



Bland County, 1957
Crab Orchard Creek Dam Failure
Source: Mount Rogers PDC 2004 Local HMP

Dam Failure

Flooding following a dam failure may occur due to any one or a combination of the following causes[2]:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments, or maintain gates, valves, or other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway;
- High winds, which can cause significant wave action and result in substantial erosion; or
- Intentional criminal acts

The mission of the Virginia Department of Conservation and Recreation (DCR) is to conserve, protect, enhance, and advocate the wise use of the Commonwealth's unique natural, historical, recreational, scenic, and cultural resources. DCR's Division of Dam Safety and Floodplain Management administers the Virginia Dam Safety Program, under the authority of the Virginia

Soil and Water Conservation Board. The dam safety division regulates impounding structures in the Commonwealth to ensure that they are 'properly and safely constructed, maintained and operated.'[3] The regulations promulgated to achieve these ends are recorded in the Virginia Administrative Code.[4] Ongoing dam inspections and Virginia's participation in the National Dam Safety Program maintained by FEMA and the US Army Corps of Engineers serve as a preventative measure against dam failures. Disaster recovery programs include assistance to dam owners and local officials in assessing the condition of dams following a flood disaster and assuring the repairs and reconstruction of damaged structures in compliance with the National Flood Insurance Program (NFIP) regulations.

Dams are classified with a hazard potential depending on the downstream losses estimated in event of failure. Hazard potential is not related to the structural integrity of a dam but strictly to the potential for adverse downstream effects if the dam were to fail. Regulatory requirements, such as the frequency of dam inspection, the standards for spillway design, and the extent of emergency operations plans, are dependent upon the dam classification. Table 3.11-1 provides additional information on these classes and the possible effects on downstream areas if failure were to occur.

Table 3.11-1: Dam Classification System in Virginia[5]

Hazard Potential	Description	Inspection
High (Class I)	Failure will cause probable loss of life or serious economic damage (to buildings, facilities, major roadways, etc.)	Annual, with inspection by a professional engineer every 2 years.
Significant (Class II)	Failure may cause loss of human life or appreciable economic damage (to buildings, secondary roadways, etc.)	Annual, with inspection by a professional engineer every 3 years.
Low (Class III)	Failure would result in no expected loss of human life, and cause no more than minimal economic damage	Annual, with inspection by a professional engineer every 6 years.

The owner of each regulated high, significant, or low hazard dam is required to apply to DCR for an Operation and Maintenance Certificate. The application must include an assessment of the dam by a licensed professional, an Emergency Action Plan, and the appropriate fee(s), submitted separately. An executed copy of the Emergency Action Plan or Emergency Preparedness Plan must be filed with the appropriate local emergency official and the Virginia Department of Emergency Management[6].

The Virginia Soil and Water Conservation Board (VSWCB), a division of DCR, issues Regular Operation and Maintenance Certificates to the dam owner for a period of six years. If a dam has a deficiency but does not pose imminent danger, the board may issue a Conditional Operation

and Maintenance Certificate, during which time the dam owner is to correct the deficiency. After a dam is certified by the board, annual inspections are required either by a professional engineer or the dam owner, and the Annual Inspection Report is submitted to the regional dam safety engineer.

Levee/Floodwall Failure

FEMA defines a levee as 'a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to reduce the risk from temporary flooding. A levee designed to provide flood protection from at least the 1% annual chance flood is eligible for accreditation by FEMA. When accredited, the area protected by the levee will be mapped as a moderate risk zone instead of a high-risk zone on the Flood Insurance Rate Map (FIRM)[7].

Before a levee can be accredited, it must complete FEMA's levee certification process which focuses exclusively on design construction standards that must be certified by a licensed engineer or related federal agency[8].

Previously, there were seven communities in Virginia that had record of levee coordination with FEMA through the Provisionally Accredited Levee (PAL) process. Three levee systems - James River Levee System (Richmond), Bridgewater Levee System (Rockingham), and Norfolk Floodwall System (Norfolk) - secured accreditation in 2012. In addition, the A. Raymon Thacker Levee/Floodwall System (Albemarle) was working on certification[9]. As of this plan update, records indicate that one levee – the Lower Long Branch levee in Fairfax County – has PAL status[10]. There are other levees in Virginia that have never been recognized as providing 100-year protection, or have been de-accredited. De-accreditation does not necessarily mean the levee no longer can provide 100-year flood protection, but may mean that the community or levee owner did not provide the necessary documentation to prove protection.

On the current Flood Insurance Study (FIS), dated February 17, 2017, the Norfolk Floodwall System has not been demonstrated by the community or levee owner(s) to meet the requirements of Section 65.10 of the NFIP regulations in 44CFR as it relates to the levee's capacity to provide 1% annual chance flood protection. The area is marked in the FIS report as potential of flood hazard data changes based on further review.

Many of the causes and effects of levee failure are similar to dam failure.

Historic Occurrence

There are no comprehensive databases of historical dam failures or flooding following a dam failure in Virginia. Most failures occur due to lack of maintenance of dams in combination with major precipitation events, such as hurricanes and thunderstorms.

- The muck dam at Saltville broke and flooded the community of Palmertown, killing 19 people and dislodging several homes from their foundations on Christmas Eve in 1924[11].
- In 1957 the Crab Orchard Creek Dam failed due to heavy rains; no one was hurt, but the estimated damage came to half a million dollars[12].
- In 1969, Lake Louisa Dam failed because of Hurricane Camille[13].
- Rainfall from Tropical Storm Agnes caused the failure of the Barcroft Dam in Fairfax County on June 21, 1972[14].
- Hurricane Floyd in 1999 caused twelve unregulated dams to break in eastern Virginia, one being the Cow Creek Dam in Gloucester County[15].
- Recent failures have included the Timberlake Dam, which killed two in 1995 and cost nearly one million dollars to rebuild, the Powhatan Lakes Dam, which failed due to a heavy storm during the summer of 2004 and caused over one million dollars in damage[16], and Falling Creek Dam in Chesterfield County, which was overtopped during Tropical Storm Gaston flooding in late summer 2004.
- Several dams failed or were overtopped following Tropical Depression Ernesto in 2006.
- The Kingstowne Park Dam in Fairfax County failed in 2010, resulting in the almost complete drainage of two lakes and the destruction of a variety of fish and wildlife habitats, as well as the loss of recreational areas[17].

Risk Assessment

Although flood inundation maps are a requirement of the current Impounding Structure Regulations[18], DCR does not currently have this information available in a digital form for all dams. If available, the maps would illustrate the probable area of flooding downstream of a dam in the event of failure. Lacking such data, this plan's risk assessment was based solely on a simple DCR database of dam location and classification.

Probability

Predicting the probability of flooding due to dam failure requires a detailed, site-specific engineering analysis for each dam in question. Failure may result from hydrologic and hydraulic design limitations, or from geotechnical or operational factors. The data and time necessary to perform a probabilistic failure analysis for each dam in Virginia is beyond the scope of this plan.
The probability of dam failure due to hydrologic and hydraulic design limitations is related to the regulatory standards for dam spillway design in Virginia. Dams are required to safely pass a spillway design flood (SDF) without failure, as indicated in Table 3.11-2.

Table 3.11-2: Performance Standards for Dams[19]

Hazard Potential	Spillway Design Flood (SDF) B for New Construction F	Spillway Design Flood (SDF) B for Existing Impounding Structures F, G	Minimum Threshold for Incremental Damage Analysis
High	PMFC	0.9 PMPH	100-YRD
Significant	.50 PMF	.50 PMF	100-YRD
Low	100-YRD	100-YRD	50-YRE

Note that a dam may be designed to a slightly lower standard than the spillway design flood based on a detailed incremental damage analysis showing that using the higher design flood does not significantly worsen downstream flooding. Low hazard dams expected to result in no loss of human life and no economic damage to any property, except the dam owners, may be exempted from the spillway design standards, as well as many of the otherwise applicable regulations.

Impact & Vulnerability

Failure of dams may result in catastrophic localized damages. Vulnerability to dam failure is dependent on dam operations planning and the nature of downstream development. Depending on the elevation and storage volume of the impoundment, the impact of flooding due to dam failure may include loss of human life, economic losses such as property damage and infrastructure disruption, and environmental impacts such as destruction of habitat. Evaluation of vulnerability and impact is highly dependent on site-specific conditions; no broad-brush approach can be applied at a statewide level.

Owners of impounding structures are required to have dam break inundation zone maps that meet the standards of the Virginia Impounding Structure Regulations[20]. The properties that are identified within the dam break zone are recorded in the dam safety emergency action plan for that impoundment. DCR is pursuing efforts to make this information available in a digital form. Such data would greatly improve ability to identify impact and vulnerability due to dam inundation.

Risk

Based on data from the US Army Corps of Engineers (USACE) National Inventory of Dams (NID), there are approximately 2,919 dams in the Commonwealth. Most dams in Virginia are classified as Low hazard (44%). Significant hazard structures make up 18%, and 20% do not have a hazard classification determined. The remaining 16% are classified as High hazard by the USACE's NID. Of the 2,919 dams inventoried, the clear majority – 2,512 (86%) - are privately owned.[21]

Due to the lack of specific data on dam failure probability or inundation zones, the potential risk to state facilities and critical facilities was not estimated for this revision of the plan. A detailed pseudo-inundation zone map could be developed using detailed terrain models and certain simplifying assumptions, although such an analysis would represent a significant undertaking. Given that Virginia's new Impounding Structure Regulations require dam break inundation zone mapping, the most efficient course of action is to let DCR compile this data into a usable format.

DCR maintains a separate inventory of regulated dams in Virginia, and is responsible for regulating more than 2,900 impoundment structures[22]. Because of the number of structures in the Commonwealth, the remainder of this discussion will focus on the structures classified by DCR as High hazard. There are 53 such structures in Virginia.

Figure 3.11-1 shows the locations of the High hazard dams in the state for which coordinates were available.

VDEM Region 1 has four High hazard dams, according to DCR. VDEM Region 2 has six; Regions 3 and 5 each have 12 High hazard dams. Regions 4 and 7 both have five, and Region 6 has a total of nine High hazard dams. Table 3.11-3 details the number of High hazard dams per jurisdiction. Figures 3.11-2 through 3.11-8 show the locations of High hazard dams within each VDEM Region (for which coordinates were available).

Figure 3-11.1: High Hazard Dams in Virginia[23]

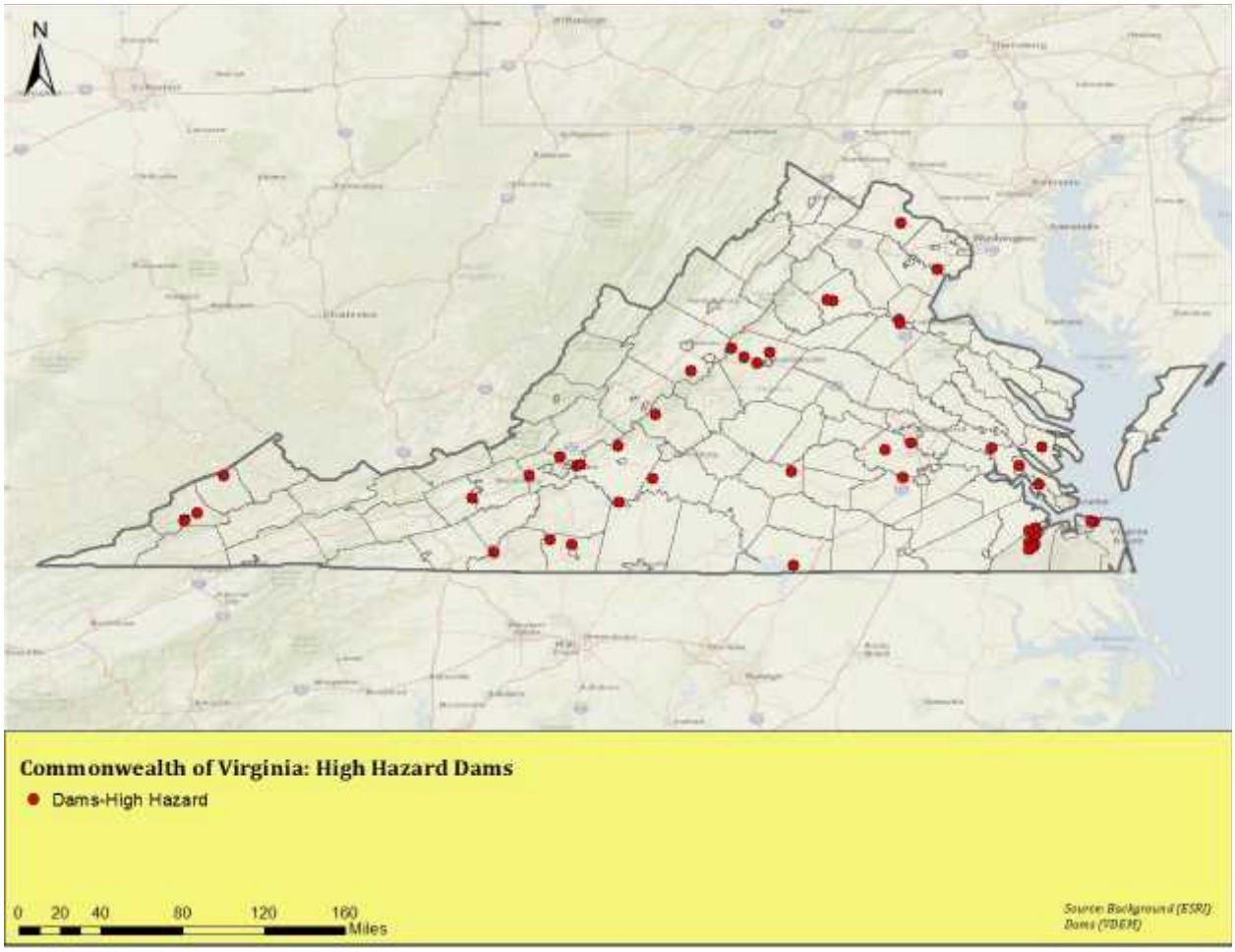


Table 3.11-3: Virginia High Hazard Dam Inventory[24]

Jurisdiction	Dam Name	Dam Operator	Water Reservoir Name	Water Reservoir Location
Albemarle County	Totier Creek Dam	Rivanna Water & Sewer Authority	Totier Creek Reservoir	Albemarle County
Albemarle County	Ragged Mountain Dam	Rivanna Water & Sewer Authority	Charlottesville Reservoir	Albemarle County
Albemarle County	Beaver Creek Dam #1	Rivanna Water & Sewer Authority	Beaver Creek Reservoir	Albemarle County
Albemarle County	South Rivanna Dam	Rivanna Water & Sewer Authority	Rivanna Reservoir	Albemarle County
Albemarle County	Spring Hollow Dam	Rivanna Water & Sewer Authority	Charlottesville Reservoir	Albemarle County
Amherst County	Pedlar River Dam	City of Lynchburg	Lynchburg Reservoir	Amherst County
Augusta County	Coles Run Reservoir	Augusta County Service Authority	Coles Run Reservoir	Augusta County
Bedford County	Smith Mountain Dam	AEP	Smith Mountain Lake	Bedford Pittsylvania, Franklin
Bedford County	Stoney Creek Reservoir Dam (Bedford)	Bedord Regional Water Authority	Stoney Creek Reservoir	Bedford County
Bedford County	Falling Creek Reservoir Dam (Bedford)	Western Virginia Water Authority	Falling Creek Reservoir	Bedford County
Bedford County	Beaverdam Reservoir Dam	Western Virginia Water Authority	Beaverdam Reservoir	Bedford County
Botetourt County Roanoke County	Carvins Cove Dam	City of Roanoke	Carvins Cove Reservoir	Botetourt County Roanoke County
Campbell County	Brookneal Dam	Town of Brookneal Utility Dept.	Brookneal Reservoir	Campbell County
Campbell County	Otter River Raw Water Terminal Reservoir	Campbell County Utilities & Service Authority	Otter River Raw Water Terminal Reservoir	Campbell County
Charlotte County	Roanoke Creek Dam #70A	Town of Keysville	Keysville Reservoir	Charlotte County
Chesterfield County	Swift Creek Reservoir Dam	Chesterfield County	Swift Creek Reservoir	Chesterfield County
Chesterfield County	Falling Creek Reservoir Dam	Chesterfield County	Falling Creek Reservoir	Chesterfield County

Jurisdiction	Dam Name	Dam Operator	Water Reservoir Name	Water Reservoir Location
Chesterfield County	Brasfield Dam (Lake Chesdin)	Appomattox River Water Authority	Brasfield Reservoir	Chesterfield County
City of Newport News	Lee Hall Reservoir Dam	City of Newport News Waterworks	Lee Hall Reservoir	City of Newport News
City of Norfolk	Lake Whitehurts	City of Norfolk DPU	Lake Whitehurst	City of Norfolk
City of Norfolk	Lake Burnt Mills Dam	City of Norfolk DPU	Lake Burnt Mills	City of Suffolk
City of Norton	Lower Norton Reservoir Dam	City of Norton	Lower Norton Reservoir	City of Norton
City of Norton	Upper Norton Reservoir Dam	City of Norton	Upper Norton Reservoir	City of Norton
City of Suffolk	Western Branch Dam	City of Norfolk DPU	Western Branch Reservoir	City of Suffolk
City of Suffolk	Lake Cohoon	City of Portsmouth DPU	Lake Cohoon	City of Suffolk
City of Suffolk	Lake Mean Dam	City of Portsmouth DPU	Lake Meade	City of Suffolk
City of Suffolk	Godwins Millpond Dam	City of Suffolk DPU	Godwins Millpond	City of Suffolk
City of Suffolk	Lake Kilby Dam	City of Portsmouth DPU	Lake Kilby	City of Suffolk
City of Suffolk	Speight's Run Dam	City of Portsmouth DPU	Speight's Run Reservoir	City of Suffolk
City of Virginia Beach	Little Creek Reservoir Dam	City of Norfolk DPU	Little Creek Reservoir	City of Virginia Beach
Culpepper County	Lake Pelham Dam	Town of Culpepper	Lake Pelham	Culpepper County
Culpepper County	Mountain Run Dam #50	Town of Culpepper	Mountain Run Lake	Culpepper County
Dickenson County	John W. Flannagan Dam	USACE	John W. Flannagan Reservoir	Dickenson County
Gloucester County	Beaverdam Reservoir Dam	Gloucester County	Beaverdam Reservoir	Gloucester County
Henry County	Beaver Creek Dam	City of Martinsville Water Dept	Martinsville Reservoir	Henry County
Henry County	Philpott Dam	USACE	Philpott Lake	Henry County
Loudoun County	JT Hirst Reservoir Dam	Town of Purceville	JT Hirst Reservoir	Loudoun County

Jurisdiction	Dam Name	Dam Operator	Water Reservoir Name	Water Reservoir Location
Loudoun County	Goose Creek Dam	Loudoun Water	Goose Creek Reservoir	Loudoun County
Loudoun County	Beaverdam Creek Dam	Loudoun Water	Beaverdam Reservoir	Loudoun County
Louisa County	South Anna Dam #22	Louisa County Water Authority	Northeast Creek Reservoir	Louisa County
Madison County	White Oak Dam #1	Rapidan Service Authority	White Oak Lake	Madison County
Mecklenburg County	John H. Kerr Dam	USACE	John H. Kerr Reservoir (aka Buggs Island Lake)	Mecklenburg County
New Kent County	Diascund Creek Reservoir Dam	City of Newport News Waterworks	Diascund Creek Reservoir	New Kent County
Orange County	Orange Raw Water Reservoir Dam	Town of Orange	Orange Raw Water Reservoir Dam	Orange County
Patrick County	Townes Dam	City of Danville	Point of Lookout Reservoir	Patrick County
Prince Edward County	Bush River Dam #12	Prince Edward County	Sandy River Reservoir	Prince Edward County
Prince William County	Upper Occoquan Dam	Fairfax County Water Authority	Occoquan Reservoir	Prince William County
Pulaski County	Claytor Dam	AEP	Claytor Lake	Pulaski
Roanoke County	Clifford D Craig Memorial Dam	Western Virginia Water Authority	Spring Hollow Reservoir	Roanoke County
Spotsylvania County	Motts Run Reservoir Dam	City of Fredericksburg / Spotsylvania County	Motts Run Reservoir	Spotsylvania County
Stafford County	Rocky Pen Run Reservoir Dam	Stafford County Board of Supervisors	Rocky Pen Run Reservoir	Stafford County
Wise County	Bear Creek Dam	Town of Wise	Wise Reservoir	Wise County
York County	Waller Mill Reservoir Dam	City of Williamsburg	Waller Mill Reservoir	York County

Figure 3-11.2: High Hazard Dams in VDEM Region 1[25]

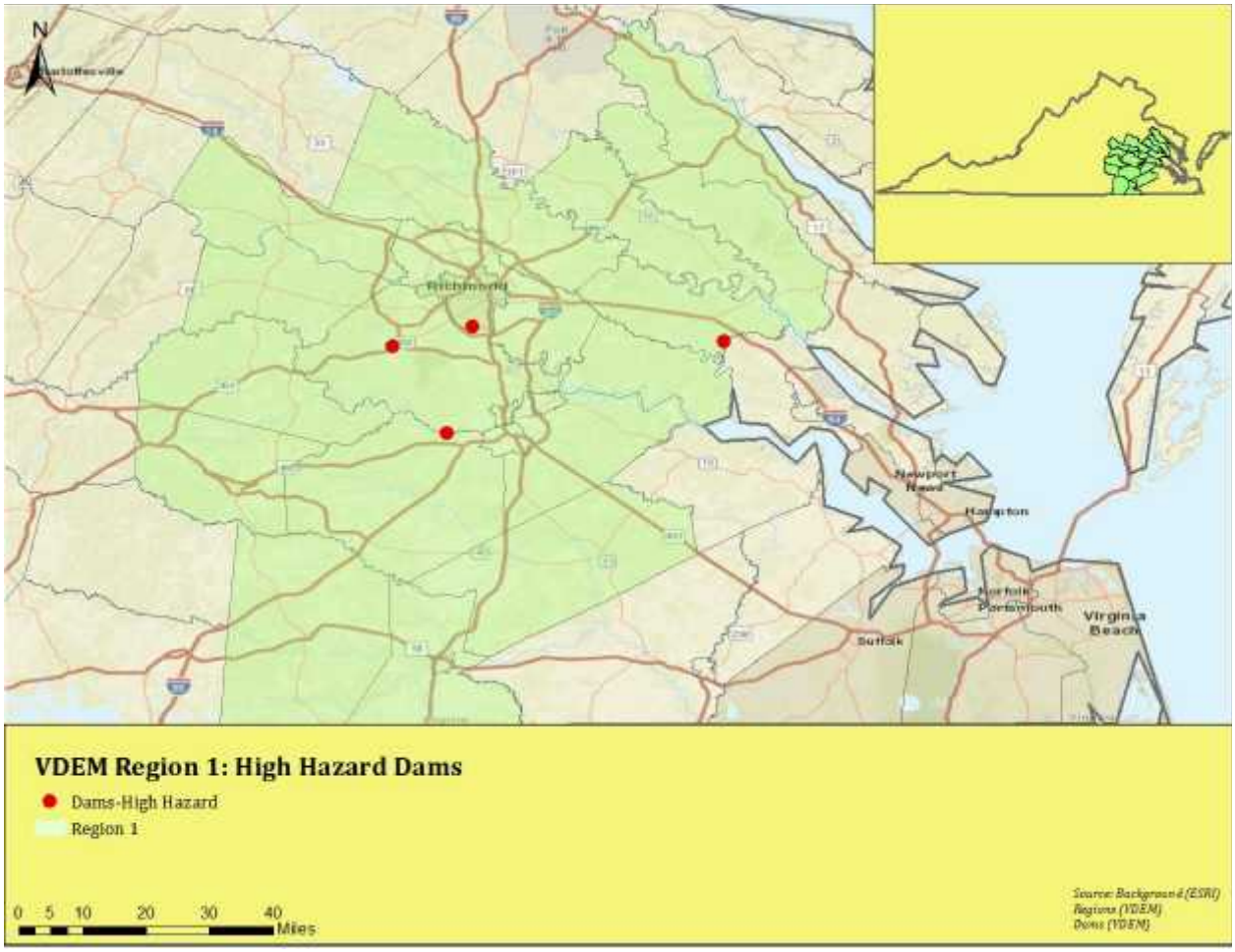


Figure 3-11.3: High Hazard Dams in VDEM Region 2[26]

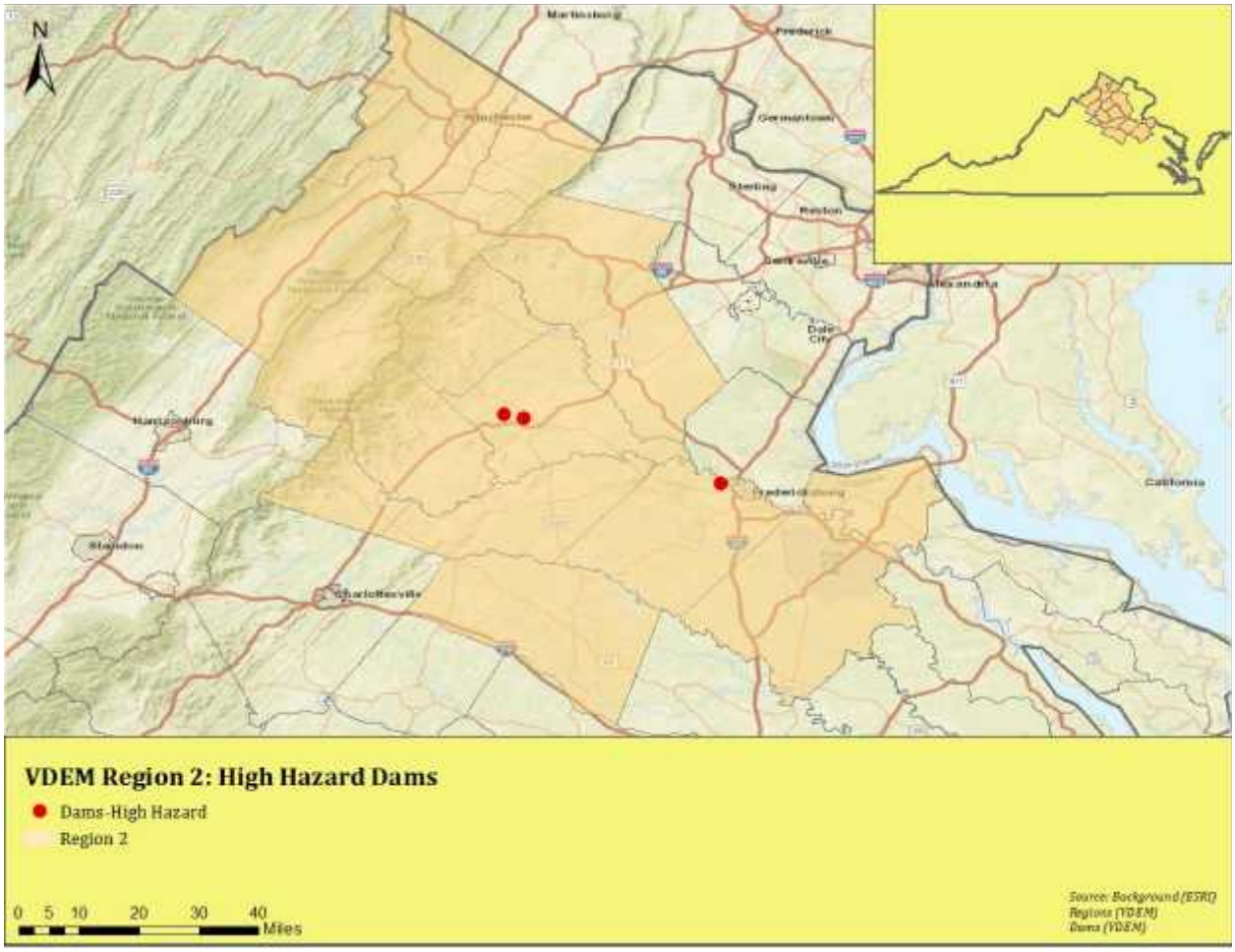


Figure 3-11.4: High Hazard Dams in VDEM Region 3[27]

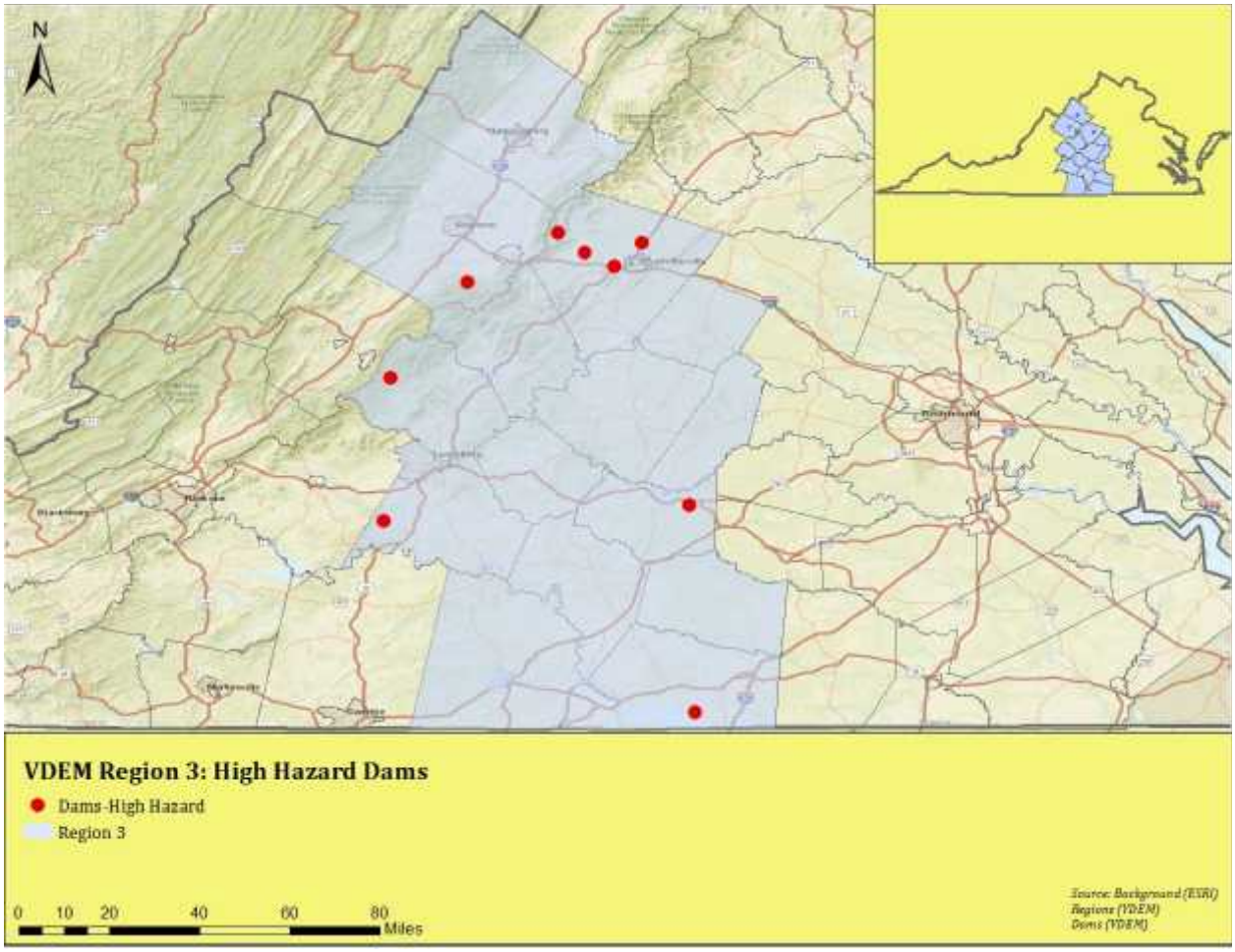


Figure 3-11.5: High Hazard Dams in VDEM Region 4[28]

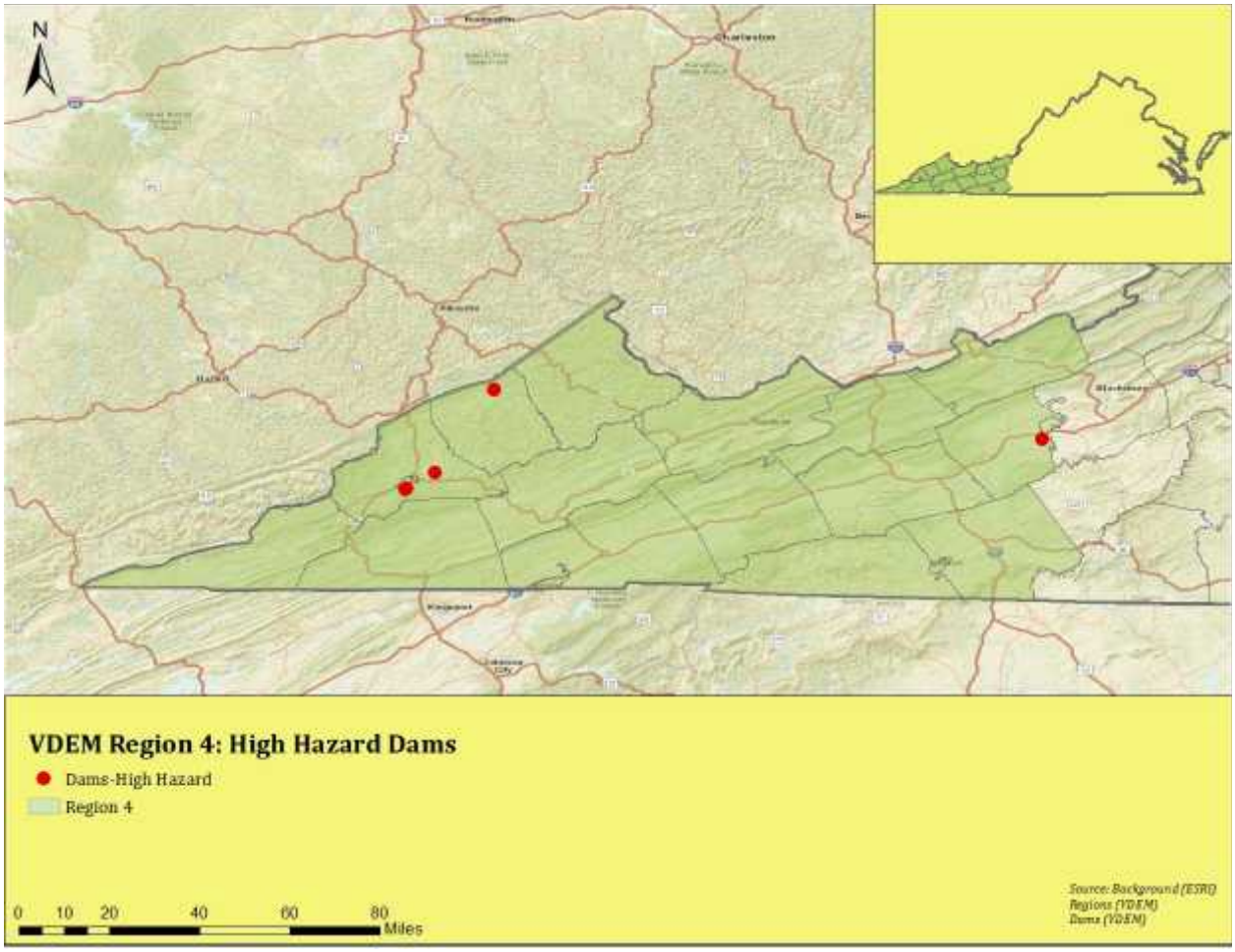


Figure 3-11.6: High Hazard Dams in VDEM Region 5[29]

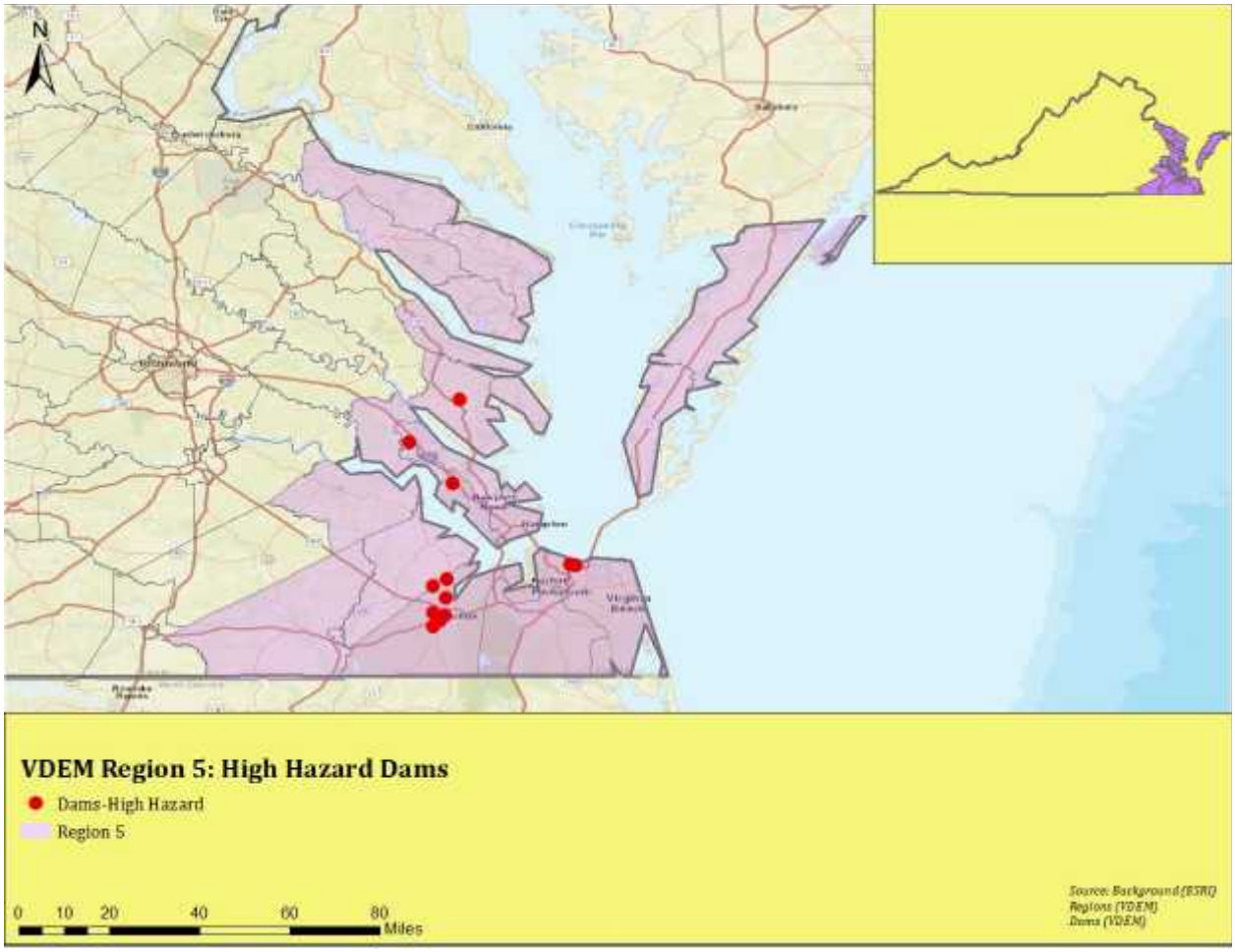


Figure 3-11.7: High Hazard Dams in VDEM Region 6[30]

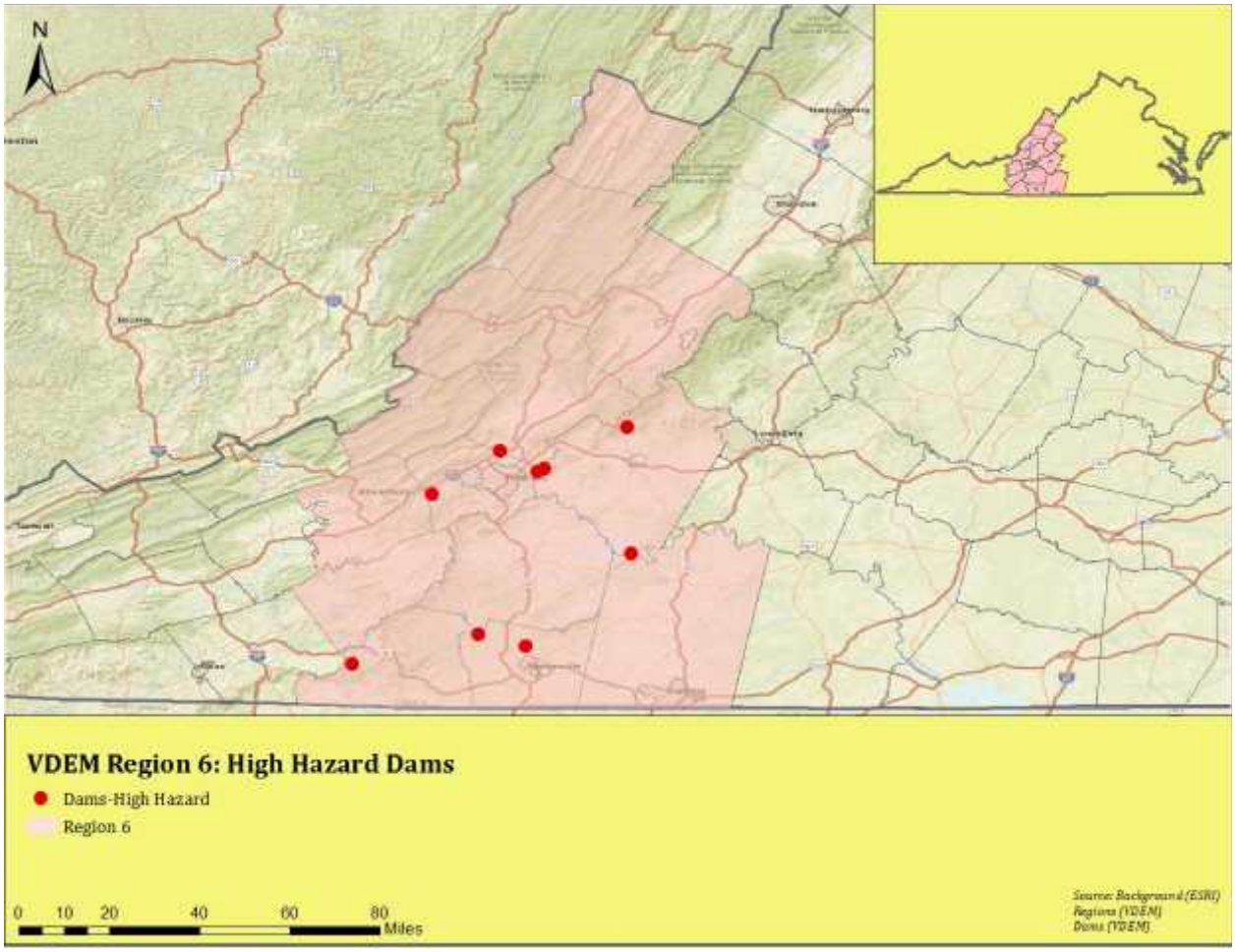
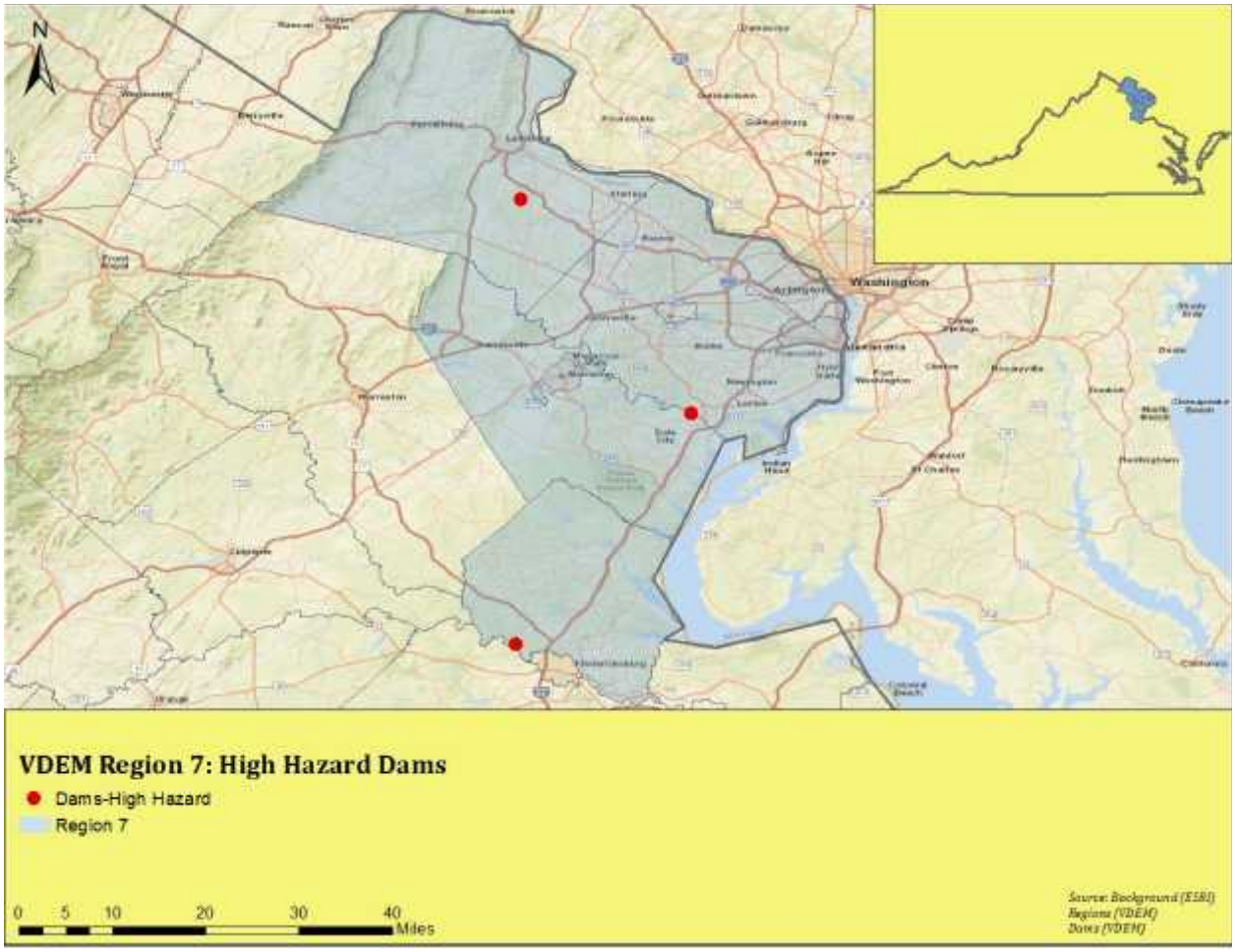


Figure 3-11.8: High Hazard Dams in VDEM Region 7[31]



Future Conditions Considerations

As precipitation amounts fluctuate and extreme weather events become more common, the flood control and impoundment infrastructure in Virginia becomes more of a concern. Like most of the country, the infrastructure in Virginia is overwhelmingly privately owned and maintained, and it is aging – in many cases, to the end of its design life. The occurrence of more frequent high intensity rainfall events may create conditions that exceed the original design criteria of these aging facilities.

During the 20-year period of January 01, 1996 to December 31, 2016, the NCEI recorded 1,154 heavy rain events in Virginia. This equates to an average of 57.7 heavy rain events per year.[32] A review of the individual records suggests that this type of event is increasing in both frequency and intensity over time. While a 20-year data set is too limited to establish a long-term outlook, it does indicate a trend. If this trend continues, it could be detrimental to flood control and impoundment infrastructure throughout Virginia. More frequent and/or more intense rain events

may increase the risk of potential failure, which increases the risk of downstream properties and residents.

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

Of the 20 local plans, one (Rappahannock-Rapidan Regional Commission) estimated losses for dam failure as negligible. The other 19 local plans did not provide loss estimates for flooding due to dam failure. Of the plans that provided a general description of the hazard, many of them provided National Inventory of Dams statistics for dams in their region. Middle Peninsula PDC and Southside PDC each provided a dam inundation zone map for a dam in their region.

Comparison with Local Ranking

Of the 20 local plans, 11 provided a hazard ranking for dam/levee failure. Most jurisdictions ranked the hazard as low or medium; only the jurisdictions in the Southside PDC (Brunswick, Halifax, and Mecklenburg counties) ranked the hazard as high. The local plan average for dam failure is medium-low. The 2018 statewide analysis ranked dam failure as low.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general terms. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). Localities and VDEM should work with DCR for future updates to this section. Since dam inundation zone maps are required, this information could be used to determine high risk areas for future development. Such data would greatly improve ability to identify impact, vulnerability, and loss estimates due to dam inundation.

Table 3.11-4: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts expected to be extensive for inundation area and moderate to light for other affected areas.
Health and Safety of Response Personnel	Unless response personnel are within the inundation area, impacts will be limited.
Continuity of Operations	Damage to facilities/personnel in the area of the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impacts to facilities, property, and infrastructure in the inundation area could be extensive depending on capacity of

Subject	Detrimental Impacts
	dam and types of development in inundation areas.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be extensive for inundation areas and moderate to light for areas outside the inundation zone.
Economic and Financial Condition	Economic and financial conditions will be impacted, potentially for long periods of time.
Public Confidence in the Jurisdiction's Governance	Localized impact expected to affect dam owners and local government entities responsible for land use planning.

Endnotes

[1] FEMA Dam Failure http://www.fema.gov/hazard/damfailure/index.shtm
[2] *State of Maryland Hazard Mitigation Plan*, 2009. Print.
[3] Code of Virginia, §10.1-605. *Conservation, Flood Protection and Dam Safety.*
[4] Virginia Administrative Code, §4VAC50-20, also known as the Virginia Impounding Structure Regulations
[5] Virginia Department of Conservation and Recreation. *Virginia Impounding Structures regulations (Dam Safety).* Retrieved 05.02.17 from http://www.dcr.virginia.gov/dam-safety-and-floodplains/document/ds-va-code-4vac50-20-10.pdf
[6] Virginia Department of Conservation and Recreation. *Dam Safety and Floodplains.* Verified 05.09.17 from http://www.dcr.virginia.gov/dam_safety_and_floodplains/
[7] Federal Emergency Management Agency. *Provisionally Accredited Levees Brochure*. Retrieved 05.02.17 from https://www.fema.gov/media-library/assets/documents/5341
[8] Federal Emergency Management Agency. *Common Questions: Levee Certification and Accreditation.* Retrieved 05.02.17 from https://www.fema.gov/media-library-data/20130726-1815-25045-4274/lv_cert_accred_faq.pdf
[9] R3levees. "Midterm levee inventory" PAL Tracking Spreadsheet 12/7/2012. Retrieved from http://www.r3levees.org/wiki/index.php?title=Midterm_levee_inventory on March 4, 2013.
[10] Virginia Department of Emergency management. DFIRM Levees. 05.10.17. Print.
[11] *Marion News.* "Charged with Blowing Dam," January 1925. On file in the historical archives at Smyth-Bland Regional Library in Marion, Virginia.
[12] Mount Rogers Region Local Mitigation Plan
[13] Thomas Jefferson Local Mitigation Plan
[14] Association of State Dam Safety Officials. *Dam Failures.* Retrieved 05.02.17 from http://www.damsafety.org/media/Documents/PDF/US_FailuresIncidents.pdf
[15] Middle Peninsula Local Mitigation Plan
[16] Richmond Local Mitigation Plan
[17] *The Washington Post.* "Dam failure drains Fairfax County lake, kills wildlife." Retrieved 05.02.17 from http://www.washingtonpost.com/wp-dyn/content/article/2010/10/05/AR2010100505873.html
[18] Virginia Administrative Code, 4 VAC 50-20-54
[19] Virginia Department of Conservation and Recreation. *Virginia Impounding Structures regulations (Dam Safety).* Retrieved 05.02.17 from http://www.dcr.virginia.gov/dam-safety-and-floodplains/document/ds-va-code-4vac50-20-10.pdf
[20] Code of Virginia, Chapter 491 *Dam Safety, Flood Prevention and Protection Assistance Fund established, mapping of dam inundation zones*. Verified 05.02.17 from http://leg1.state.va.us/cgi-bin/legp504.exe?081+ful+CHAP0491
[21] US Army Corps of Engineers. National Inventory of Dams. Retrieved 05.02.17 from http://nid.usace.army.mil/cm_apex/f?p=838:3:0::NO::P3_STATES:VA

[22] Virginia Department of Conservation and Recreation. *Dam Safety and Floodplain Management.* Retrieved 05.02.17 from http://www.dcr.virginia.gov/dam-safety-and-floodplains/
[23] Only dams with coordinate information are depicted in this figure.
[24] Virginia Department of Conservation and Recreation. High Hazard Dam Inventory. February 2017. Print.
[25] Only dams with coordinate information are depicted in this figure.
[26] Only dams with coordinate information are depicted in this figure.
[27] Only dams with coordinate information are depicted in this figure.
[28] Only dams with coordinate information are depicted in this figure.
[29] Only dams with coordinate information are depicted in this figure.
[30] Only dams with coordinate information are depicted in this figure.
[31] Only dams with coordinate information are depicted in this figure.
[32] National Centers for Environmental Information. *Storm Events Database.* Retrieved 05.09.17 from https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=51%2CVIRGINIA

Section 3.12: Karst (Sinkholes)



Russell County Sinkhole
Photo from Virginia DGMR

Description

Karst is the term commonly used to describe areas containing distinctive surficial and subterranean features, such as fissures, tubes, and caves, developed by solution of carbonate and other rocks. Karst areas are characterized by sinking streams, cavern openings, and closed depressions. When used in its broadest sense, the term karst encompasses many surface and subsurface conditions that give rise to problems in engineering geology.

In Virginia, most karst lands are underlain by soluble limestone and dolomite, collectively referred to as carbonate rock. Carbonate rocks are common in valleys west of the Blue Ridge Mountains. While karst is not the only cause of land subsidence, it tends to receive more attention in Virginia than the other causes, due to its potential for the appearance of sudden and catastrophic events. While most sinkholes in karst develop gradually due to a slow dissolution or cover subsidence, cover-collapse sinkholes can fail rapidly. Cover-collapse sinkholes are possible in areas that do not have carbonate bedrock if the underlying soil is removed, most often due to moving water, such as from a broken water line. Finally, karst terrain is also associated with marbles in the Piedmont province and the shell-rich formations in the Coastal Plain.

In addition to karst terrain, Virginia also has known active and abandoned underground mines. These are present primarily in the southwestern part of the state, in including the counties of Lee, Scott, Wise, Dickenson, Russell, Buchanan, Tazewell, and the City of Norton[1]. Other areas of the state are also dotted with old mines, including the Richmond area (coal mines), the Piedmont (gold mines), and in the Blue Ridge and Valley and Ridge (iron mines). Like karst terrain, underground mines may pose a hazard to certain types of land use, as they are typically shallower and constructed with less geologic and engineering knowledge, leaving them more prone to collapses that impact the surface.

Historic Occurrence

To date, there have been no federal disaster declarations or NCEI recorded events for karst-related sinkhole events. Currently, there is no comprehensive long-term record of past events in Virginia. Several documented occurrences have been included in Table 3.12-1. For future revisions of this section, it is recommended that the Virginia Department of Transportation be

involved to determine areas where roads experience sinkholes to improve on the incidence reporting.

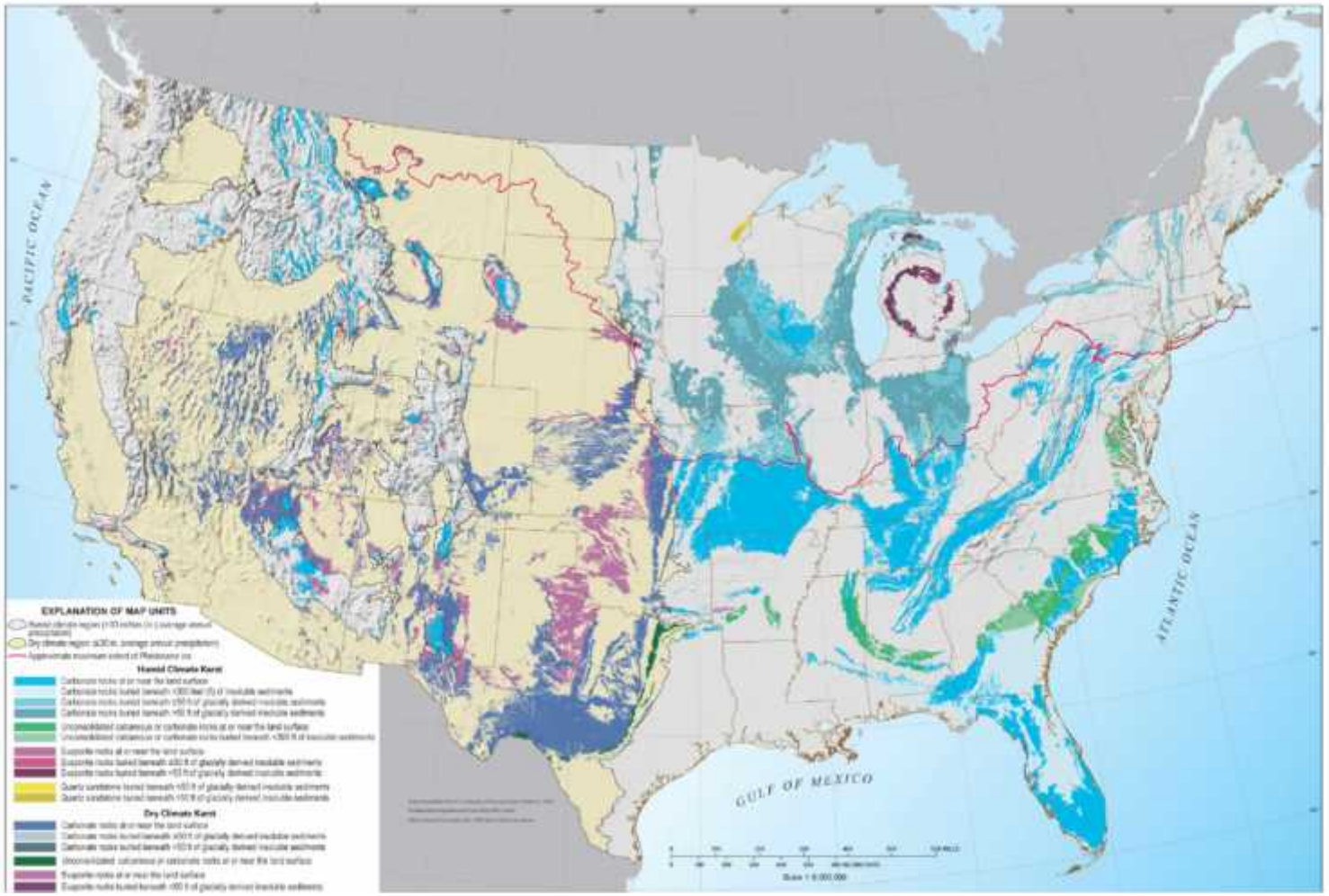
Table 3.12-1: Historical Karst Events in Virginia

Year	Location of Sinkhole	Description
1910	City of Staunton	Three sinkholes opened up on Lewis and Baldwin Street and Central Avenue in Staunton. One of the sinkholes was so large that it swallowed a 35-foot maple tree and a house. One worker was killed when he fell into one of the chasms caused by the sinkhole as it was being repaired
1977	Smyth County	A sinkhole 50 feet in diameter caused a section of State Route 91 to collapse in Smyth County. The incident took place in front of U.S. Gypsum Company offices
1992	Clarke County	A house collapsed inside of a sinkhole after the drilling of a new well on the property in Clarke County.
2000	City of Staunton	Thirty-two sinkholes were reported after 7" of rain fell in April after a long dry spell in the City of Staunton.
2001	Augusta County	Interstate 81 was closed for a nine-mile stretch in Augusta County because of the sudden appearance of three sinkholes. The largest of the three sinkholes was measured at 20 feet long, 11 feet wide and 22 feet deep and costing over $100,000 to repair.
2005	Botetourt County	A sinkhole 40 feet deep and 25 feet wide was discovered on Trinity Road (Virginia 670) in Botetourt County[2].
2006	City of Staunton	A sinkhole 18 feet deep on Interstate 64 closed one lane and shoulder in the City of Staunton.
2011	Town of Strasburg	A sinkhole 50 feet deep and 75 feet wide shut down Oranda road in both directions in the Town of Strasburg. The Virginia Department of Transportation believed this to be one of the larger sinkholes they had seen. The road was closed for several days for repairs[3].
2011	Rockbridge County	Near mile marker 170, the northbound lanes of Interstate 81 had to be closed because of a sinkhole[4].
2013	Giles County	A mudslide and several sinkholes were reported along Route 100 and Meadows Road near Staffordsville.
2015	Woodstock	A 20-foot sinkhole closed both lanes of northbound Interstate 81, resulting in significant travel delays during repairs. VDOT believed the sinkhole was formed by a cracked box culvert used to carry water from one side of the roadway to the other[5].

Risk Assessment

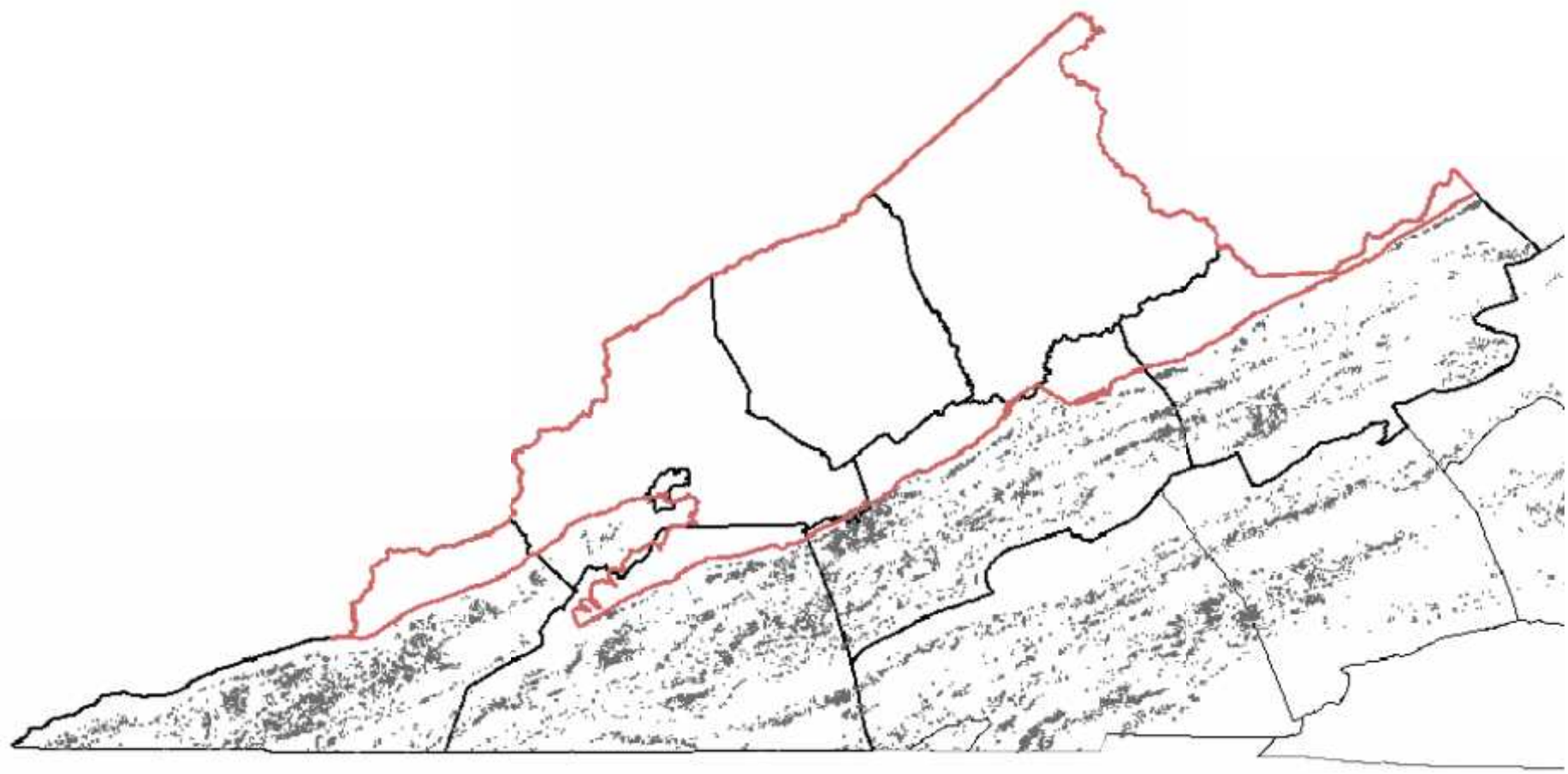
The *Karst in the United States; A Digital Map Compilation and Database* report was produced by the USGS. This report, and the mapping information it contains, describes new digital maps delineating areas of the US that have karst or the potential for the development of karst. Figure 3.12-1 shows the areas that contain karst or the potential for karst in soluble rocks in the contiguous US, including Virginia[6].

Figure 3.12-1: Karst Regions and Potential Karst Regions in the US[7]



The Virginia Department of Mines, Minerals, and Energy (DMME) provides imagery that illustrates the location of known sinkholes in Virginia. This image can be seen in Figure 3.12-2.

Figure 3.12-2: Known Sinkhole Locations in the Westernmost Part of Virginia[8]



Note: karst topography appears in gray.

Probability

Karst formations develop in specific ways that are influenced by unique local conditions. Sinkholes can be induced through natural or human causes. Sinkholes that occur naturally usually form by the slow downward dissolution of carbonate rock though bedrock collapse in areas that overlie caverns[9]. Human induced sinkholes can be triggered by simple alteration in the local hydrology. Inadequate drainage along highways and increased runoff from pavements can also be sources of sinkhole development.

The probability of karst cannot be expressed in terms of specific return periods or recurrence intervals as easily as it can be for other hazards. As a result, the probability analysis consists of delineating those regions experience relatively more karst.

Impact and Vulnerability

The most important environmental issue with respect to karst is the sensitivity of karst aquifers to groundwater contamination. Karst covers an estimated 10-20% of the earth's surface and provides 40-50% of the world's drinking water, which means care must be taken to mitigate negative human impacts and allow sustainable development. Karst systems are highly vulnerable to pollution, water withdrawals, and changes in land use. The dissolution of limestone creates voids in the earth that can lead to collapses and directly impact people and the built environment in the immediate area of the collapse. These collapses can lead to property damage, infrastructure damage, and injuries or loss of life[10].

Sinkholes can cause property damage, loss of life or injury, transportation disruptions, utility failures, and interruptions in the delivery of emergency services.

Risk

Risk, strictly defined as probability multiplied by impact, cannot be fully estimated for karst due to the lack of historical data and detailed mapping. To assess risk, mapping by the USGS of karst regions in Virginia was used as the probability of future occurrence.

The principal area affected by sinkholes is the Valley and Ridge province, an extensive karst terrain underlain by limestone and dolomite, but the narrow marble belts in the Piedmont and some shelly beds in the Coastal Plain are also pocked with sinkholes[11]. This assessment focuses on areas vulnerable to collapse resulting from geologic formations prone to dissolution. It does not include areas underlain materials which can be subject to abandoned mine collapse (such as old coal, gold, or iron mines), or urban areas where failed underground infrastructure can lead to sinkholes.

State Facility Risk

To determine which facilities are at risk for land subsidence, state facilities were intersected with the USGS karst geology layer. The results of this analysis indicate 2,433 buildings are located within identified karst formation areas. Annualized loss estimates were not calculated for state facilities due to the scale of available karst mapping, the lack of available valuation data, and the lack of probabilities of future occurrences.

The 2,433 buildings located in karst formation areas can be divided between 31 different agencies in Virginia. Those agencies are listed in Table 3.12-2, by agency and number of buildings. The agencies listed represent approximately 18% of the buildings owned by the Commonwealth.

Table 3.12-2: Agencies with Assets in Karst Formation Areas

Agency	Number of Buildings in Karst Zone	Predominate Use of Buildings
Virginia Department of Alcoholic Beverage Control	10	Other (retail)
Virginia Department for Aging and Rehabilitative Services	1	Support
Virginia Department of Behavioral Health and Development Services	217	Medical, Housing, Utility, Education, Support
Virginia Department of Criminal Justice Services	1	Research
Virginia Department of Conservation and Recreation	178	Recreational, Housing, Storage, Utility, Support
Virginia Department of Environmental Quality	2	Research, Utility
Virginia Department of Forensic Science	2	Research
Virginia Department of Game and Inland Fisheries	62	Recreational, Housing, Agriculture, Storage
Virginia Department of General Services	3	Research
Virginia Department of Historic Resources	5	Housing, Agriculture
Virginia Department of Military Affairs	49	Armory, Office, Storage
Virginia Department of Motor Vehicles	4	Office
Virginia Department of Corrections	290	Housing, Medical, Food, Office, Agriculture
Virginia Department of Forestry	69	Office, Housing, Storage, Fire Service
Virginia Department of Veterans Services	6	Medical, Office
Frontier Culture Museum of Virginia	2	Historic
James Madison University	189	Education, Housing, Agriculture, Utility
Northern Virginia Community College	1	Education
Radford University	62	Education, Recreational
Southwest Virginia Higher Education Center	2	Education

Agency	Number of	Predominate Use of
University of Virginia	54	Education, Housing, Agriculture, Utility
Virginia Community College System	91	Education, Agriculture, Support, Utility
Virginia Department of Agriculture and Consumer Services	6	Research, Office
Virginia Department of Health	1	Office
Virginia Department of Transportation	780	Office, HazMat, Storage, Fuel, Recreation
Virginia Employment Commission	4	Office
Virginia Military Institute	141	Education, Housing, Recreation, Utility, Support
Virginia Polytechnic Institute and State University (Virginia Tech)	84	Education, Housing, Agriculture, Office
Virginia School for the Deaf and Blind	26	Education, Housing, Recreation, Medical
Virginia State Police	55	Communications, Office
Woodrow Wilson Rehabilitation Center	36	Housing, Medical, Support, Recreational
Total:	**2,433**	

Critical Facility Risk

Risk for critical facilities was calculated in the same fashion described above for state facilities. Approximately 3% of state-owned assets are critical facilities in regions with some karst geology. Table 3.12-3 shows the number of critical facilities identified in karst formation areas, by use. Utilities, fuel service/storage, and emergency response represent many critical facilities in known karst areas. Annualized loss estimates were not calculated for critical facilities due to the scale of available karst mapping, limited information on mapped critical facilities (including valuation data), and the lack of probabilities of future occurrences.

Table 3.12-3: Critical Facilities in Karst Formation Areas

Critical Facility Use	Number in Karst Zone
Animal Health	2
Armory	11
Childcare	1
Communications	18
Emergency Operations Center	1
Fire Service/Support/Suppression	9
Food Service/Storage	14
Fuel Storage/Delivery	110

Critical Facility Use	Number in Karst Zone
Hazardous Materials Storage	87
Medical Services/Support/EMS	40
Public Safety	32
Research	24
Special Populations Housing	3
Utilities	113
Total:	**465**

Karst Risk to Energy Pipelines

Pipeline infrastructure, underlain by karst terrain, can be damaged by a collapse in the supporting soil.

Future Conditions Considerations

Karst development is influenced by climate. The indirect effects include biogeomorphic impacts of biota, and base-level changes associated with sea-level and river incision or aggradation[12]. Examples of the direct relationship are well documented, such as the 2014 incident in Siberia, Russia in which a large sinkhole (30 meters wide) formed as methane gas was released as permafrost thawed due to increased temperatures in the region[13]. Another example comes from Melbourne and Sydney, Australia, where sinkholes have historically been rare. Though the sinkholes that began occurring there in 2015 were man-made – likely caused by broken water mains, poorly built water retention systems, and failing infrastructure – they were fueled by a combination of prolonged drought conditions followed by heavy rains[14]. While the circumstances in both examples are different from the circumstances in Virginia, both scenarios show the direct relationship between changing climate and sinkholes in karst formations. Given Virginia's extensive karst formations, the combination of increased drought conditions and heavy rains can be expected to increase the frequency – and possibly the severity – of karst-related sinkholes in the Commonwealth.

Jurisdictional Risk

To compare different hazards based on a common system, inputs for karst were very limited because of no recorded NCEI events. To be able to include karst in the risk assessment some general assumptions were made. Geographical Extent, using USGS Karst Topography maps, was the primary basis for establishing risk and was calculated as a percent of the jurisdictional area. In lieu of probability of future occurrence, areas with more karst were assumed to be at greater risk.

These parameters in the karst risk assessment are provided in Table 3.12-4, along with the total ranking. There are currently no karst related records in NCEI; thus, the lowest ranking score (1) was assigned to the annualized data for events, damages, and fatalities and injuries to be able to

compare karst to the other hazards, as described in section 3.5. Population vulnerability and density was not altered for this calculation.

Jurisdictions ranked as at higher risk for Virginia include

- City of Harrisonburg
- City of Winchester
- City of Roanoke
- Roanoke County

Communities in the Valley and Ridge province have a large percent of karst geology and therefore have a higher risk associated with them. Many of these areas also have an extensive history of sinkhole development. The jurisdictions identified at higher risk are urbanized areas in the Western, more mountainous parts of the state.

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information informs the text and figures of each of the sections in this revision.
The nine local plans that specifically included karst as a hazard did not provide loss estimates for the hazard. Of the plans that provided a general description of karst, some of them intersected US Census data with the USGS karst zones to estimate the population located within a karst zone; most these assessments were general in nature.

The consensus in the local plans is that there is no way to estimate potential damages. Some local plans estimated the exposure of buildings and infrastructure, but this was done in a general way, based on proximity to identified sinkholes.

Comparison with Local Ranking

No local plans ranked karst as a high hazard. Central Shenandoah Valley PDC, Hampton Roads PDC, and Loudoun County (in the NOVA plan) all ranked karst as a medium hazard for their regions; however, the hazard was often combined or discussed with other geologic hazards, such as landslides and sinkholes. A review of the text made clear that while karst was described as the hazard, it was sinkholes and/or landslides that was the actual concern for the jurisdictions.

Six plans ranked karst as low (including the other participating jurisdictions in the NOVA plan). The 2018 statewide analysis also has ranked karst as low and is consistent in that regard with the local plans. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general terms. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). A few plans exclusively noted that they have zoning ordinances related to sinkhole development or they have mitigation actions to address these in the future.

Table 3.12-4: Karst (Sinkholes) Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Low	Low	Low	Low	Low
Albemarle	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Alexandria, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Alleghany	Low	Low	Low	Low	Low	Low	Low	Low
Amelia	Low	Low	Low	Low	Low	Low	Low	Low
Amherst	Medium	Medium	Low	Low	Low	Low	Low	Low
Appomattox	Low	Low	Low	Low	Low	Low	Low	Low
Arlington	High	High	Low	Low	Low	Low	Low	Medium-Low
Augusta	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Bath	Low	Low	Low	Low	Low	Low	Low	Low
Bedford	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Bland	Low	Low	Low	Low	Low	Low	Low	Low
Botetourt	Medium	Medium	Low	Low	Low	Low	Low	Medium-Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Brunswick	Medium	Low	Low	Low	Low	Low	Low	Low
Buchanan	Medium	Low	Low	Low	Low	Low	Low	Low
Buckingham	Low	Low	Low	Low	Low	Low	Low	Low
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Campbell	Medium	Medium	Low	Low	Low	Low	Low	Low
Caroline	Medium	Low	Low	Low	Low	Low	Low	Low
Carroll	Medium	Medium	Low	Low	Low	Low	Low	Low
Charles City	Low	Low	Low	Low	Low	Low	Low	Low
Charlotte	Low	Low	Low	Low	Low	Low	Low	Low
Charlottesville, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Chesapeake, City of	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Chesterfield	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Clarke	Low	Medium	Low	Low	Low	Low	Low	Low
Colonial Heights, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Covington, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Craig	Low	Low	Low	Low	Low	Low	Low	Low
Culpeper	Medium	Medium	Low	Low	Low	Low	Low	Low
Cumberland	Low	Low	Low	Low	Low	Low	Low	Low
Danville, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Dickenson	Low	Low	Low	Low	Low	Low	Low	Low
Dinwiddie	Medium	Low	Low	Low	Low	Low	Low	Low
Emporia	Low	Medium-High	Low	Low	Low	Low	Low	Low
Essex	Low	Low	Low	Low	Low	Low	Low	Low
Fairfax	High	High	Low	Low	Low	Low	Low	Medium-Low
Fairfax, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Falls Church, City of	Low	High	Low	Low	Low	Low	Low	Low
Fauquier	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Floyd	Low	Low	Low	Low	Low	Low	Low	Low
Fluvanna	Medium	Medium	Low	Low	Low	Low	Low	Low
Franklin	Medium	Medium	Low	Low	Low	Low	Low	Low
Franklin, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Frederick	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Fredericksburg, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Galax, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Giles	Low	Low	Low	Low	Low	Low	Low	Low
Gloucester	Medium	Medium	Low	Low	Low	Low	Low	Low
Goochland	Medium	Medium	Low	Low	Low	Low	Low	Low
Grayson	Low	Low	Low	Low	Low	Low	Low	Low
Greene	Medium	Medium	Low	Low	Low	Low	Low	Low
Greensville	Low	Low	Low	Low	Low	Low	Low	Low
Halifax	Medium	Low	Low	Low	Low	Low	Low	Low
Hampton, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Hanover	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Harrisonburg, City of	Medium	High	Low	Low	Low	Low	Medium	Medium-Low
Henrico	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Henry	Medium	Medium	Low	Low	Low	Low	Low	Low
Highland	Low	Low	Low	Low	Low	Low	Low	Low
Hopewell, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Isle of Wight	Medium	Medium	Low	Low	Low	Low	Low	Medium-Low
James City	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
King and Queen	Low	Low	Low	Low	Low	Low	Low	Low
King George	Medium	Medium	Low	Low	Low	Low	Low	Low
King William	Low	Low	Low	Low	Low	Low	Low	Low
Lancaster	Low	Medium	Low	Low	Low	Low	Low	Low
Lee	Medium	Low	Low	Low	Low	Low	Low	Low
Lexington, City of	Low	High	Low	Low	Low	Low	Low	Low
Loudoun	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Louisa	Medium	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Lunenburg	Low	Low	Low	Low	Low	Low	Low	Low
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Madison	Low	Low	Low	Low	Low	Low	Low	Low
Manassas, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Manassas Park, City of	Low	High	Low	Low	Low	Low	Low	Low
Martinsville, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Mathews	Low	Medium	Low	Low	Low	Low	Low	Low
Mecklenburg	Medium	Low	Low	Low	Low	Low	Low	Low
Middlesex	Low	Medium	Low	Low	Low	Low	Low	Low
Montgomery	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Nelson	Low	Low	Low	Low	Low	Low	Low	Low
New Kent	Low	Medium	Low	Low	Low	Low	Low	Low
Newport News, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Norfolk, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Northampton	Low	Medium	Low	Low	Low	Low	Low	Low
Northumberland	Low	Low	Low	Low	Low	Low	Low	Low
Norton	Low	Medium-High	Low	Low	Low	Low	Low	Low
Nottoway	Low	Low	Low	Low	Low	Low	Low	Low
Orange	Medium	Medium	Low	Low	Low	Low	Low	Low
Page	Medium	Medium	Low	Low	Low	Low	Low	Low
Patrick	Medium	Low	Low	Low	Low	Low	Low	Low
Petersburg, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Pittsylvania	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Poquoson	Low	Medium-High	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Portsmouth, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Powhatan	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince Edward	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince George	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince William	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Pulaski	Medium	Medium	Low	Low	Low	Low	Low	Low
Radford, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Rappahannock	Low	Low	Low	Low	Low	Low	Low	Low
Richmond	Low	Low	Low	Low	Low	Low	Low	Low
Richmond, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Roanoke	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Roanoke, City of	Medium-High	High	Low	Low	Low	Low	Medium	Medium-Low
Rockbridge	Medium	Low	Low	Low	Low	Low	Medium	Low
Rockingham	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Russell	Medium	Low	Low	Low	Low	Low	Low	Low
Salem, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Scott	Medium	Low	Low	Low	Low	Low	Low	Low
Shenandoah	Medium	Medium	Low	Low	Low	Low	Low	Low
Smyth	Medium	Medium	Low	Low	Low	Low	Low	Low
Southampton	Low	Low	Low	Low	Low	Low	Low	Low
Spotsylvania	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Stafford	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Staunton, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Suffolk	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Surry	Low	Low	Low	Low	Low	Low	Low	Low
Sussex	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Tazewell	Medium	Medium	Low	Low	Low	Low	Low	Low
Virginia Beach, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Warren	Medium	Medium	Low	Low	Low	Low	Low	Low
Washington	Medium	Medium	Low	Low	Low	Low	Low	Low
Waynesboro, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Westmoreland	Low	Medium	Low	Low	Low	Low	Low	Low
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Winchester, City of	Medium	High	Low	Low	Low	Low	Medium	Medium-Low
Wise	Medium	Medium	Low	Low	Low	Low	Low	Low
Wythe	Medium	Medium	Low	Low	Low	Low	Low	Low
York	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low

For the 2018 plan, the overall hazard ranking for karst (sinkholes) is low.

Table 3.12-5: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts are expected to be moderate to severe in the impact area.
Health and Safety of Response Personnel	Limited unless sinkhole involves broken utility lines.
Continuity of Operations	Limited, unless a facility is impacted
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure around the event could be severe.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be moderate for the impacted areas. Always a potential for utility line breaks.
Economic and Financial Condition	Limited. Depending on the magnitude of the event, local economy and finances may be impacted.
Public Confidence in the Jurisdiction's Governance	Localized impacts expected to cause property owners confidence in state and local land use/development policies to waiver.

Endnotes

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Section 3.13: Landslides



June 27, 1995 Flooding and Landslides
Madison County, Virginia
Source: USGS Open File Report 97-438

Description

A landslide is the downslope transport of a mass of soil and rock material and refers to several different varieties of ground movement landforms and processes. The primary driving force for a landslide is gravity, but other factors may contribute to the failure of a slope. Landslides are usually triggered by heavy rainfall, rapid snow melt, over steepening of slopes by stream incision, or earthquakes, while certain man-made changes to the land, such as slope modification or drainage alteration, can greatly increase the likelihood of landslides. Landslides are capable of destroying buildings, rupturing gas, water, and sewer mains, and knocking out power and telephone lines while blocking transportation routes. Sometimes a landslide may move slowly down a slope, but often the movement can occur without warning and be extremely fast. Soil creep and slumping cause property damage gradually, whereas rock slides and debris flows can sweep away people and property instantaneously.

Landslides occur in many manifestations and are usually classified according to the type of material involved and the mode of downslope movement. The material can range from loose earth to blocks of solid rock. These materials may then move downslope by falling, sliding or flowing. The following are some of the more important types of mass movement:

- Rockfalls entail large blocks of bedrock breaking off a cliff face and tumbling downslope.
- Rockslides occur when a detached section of bedrock slides down an inclined surface, frequently along a bedding plane.
- Earthslides involve masses of soil moving down a slip face, usually on top of the bedrock.
- Creep is the slow, continuous, imperceptible downslope movement of soil and rock particles.
- Rotational Slides or Slumps result from the rotation of a cohesive unit of soil or rock down a slip surface, leaving a curved scarp.

- Debris flows develop on steep slopes because of heavy rainfall that saturates the soil, which under the extra weight and lubrication breaks loose and becomes slurry that takes everything with it, including large trees and houses. Channeled debris flows can reach speeds approaching a hundred miles an hour and strike without warning.

Landslides are most common in the mountainous terrain of Virginia because of the presence of steep slopes and highly fractured bedrock over shallow soils. The lower-relief areas of the Piedmont and Coastal Plain also have landslides, but they are often smaller and generated by human disturbance, such as making an over-steepened road cut. The most disastrous landslide events have been associated with heavy rainfall along the steep slopes of the Blue Ridge Mountains and the Appalachians. Areas that are prone to mass movement include areas where landslides have occurred in the past; steep slopes with an angle greater than 30 degrees; over-steepened cuts and fills, particularly due to home and road building. Research in North Carolina has revealed that about 56 percent of recent landslides happened on slopes that had been altered in some way by development[1].

Landslides are a major geologic hazard because they are widespread, occurring in all 50 states and US territories, causing up to $2 billion in damages, and leading to more than 25 fatalities on average each year[2]. Casualties in the US are primarily caused by rockfalls, rock slides, and debris flows. Expansion of urban and recreational developments into hillside areas exposes more people to landslide-prone conditions each year.

Historic Occurrence

The greatest landslide hazards are present in western and southwestern Virginia. One federal disaster declaration has been recorded for Buchanan County (1995); two other declared disasters in Nelson (1969) and Madison (1995) Counties have experienced landslides because of flooding or hurricane related events. The USGS has an informative publication titled 'Debris-Flow Hazards in the Blue Ridge of Virginia' that highlights past events, specifically the June 27, 1995 event in Madison County.

In the 2010 Hazard Mitigation Plan, scientists from the USGS determined that most of the debris-flow events between 1844 and 1985 have occurred in the Blue Ridge. Studies of stream channels found evidence of prehistoric debris flows in Madison County. Radiocarbon dating from these debris-flow deposits indicates that landslide events have repeatedly occurred there over the last 34,000 years[3].

One of the most destructive events occurred in August 1969 in Nelson County, VA. In an eight-hour span, 27-31 inches of rainwater triggered approximately 3,700 landslides, which killed more than 150 people[4].

The National Centers for Environmental Information (NCEI) *Storm Events Database* has landslide/debris flow records for King George County (1998), Tazewell County (2006), Staffordsville (2013), and Carsonville (2015)[5]. Additional sources, including local plans, were used to collect information on historical occurrences that have been included in Table 3.13-1.

Table 3.13-1: Historical Landslide Occurrences

Year	Location of Landslide	Description
1969	Nelson County	Hurricane Camille stalled over the Blue Ridge Mountains, dropping more than 30 inches of rain in less than eight hours. Flooding and numerous landslides and debris flows led to the deaths of more than 150 people, 100 injuries, destruction of more than 100 bridges, and more than $150 million in property damage. This event resulted in the most recorded deaths by a natural hazard in the Commonwealth.
1985	Potomac and Cheat River Watersheds	Affecting both Virginia and West Virginia, 72 hours of storms produced record floods and extensive landslide and debris flow activity, causing 70 deaths and a total of $1.3 billion in damage to homes, businesses, roads, and farmlands.
1987	Alleghany County	Heavy rains caused landslides along Smith Creek in the Town of Clifton Forge.
1994	Pulaski County	Landslides were observed in June when six inches of rain fell in a three hour period. The landslides knocked one home from its foundation and blocked five miles of roads.
1995	Buchanan County	Previous rains and a saturated ground caused an abandoned/sealed underground mine to burst. Water, rocks, and dirt cascaded into a home along Laurel Creek, about three miles south of Whitewood. A 26-year-old woman was buried in the basement by debris and property damage was estimated at $15,000.
1995	Madison County	During 16 hours, approximately 30 inches of rain fell in small area of Madison County. Eight people were killed in June when hundreds of landslides combined with widespread flooding. As many as 2,000 homes were affected and 35,000 acres of crops were damaged. Total property damages were estimated at $112 million.
1998	King George County	A rockslide caused a portion of local route 627 to slide down a cliff. At least 1/2 the width of the road was removed. The rockslide was partly due to repeated heavy rains, very moist soil, and minor flooding along the river during the winter of 1997/98. Major river and flash flood events in 1996 likely set the stage, over the long term, for the slide. Property damage was estimated at $150,000.
2000	City of Staunton	16 landslides were experienced along Staunton district roads.

Year	Location of Landslide	Description
2004	City of Richmond	The remnants of Tropical Depression Gaston caused severe landslides throughout the Church Hill and Riverside Drive sections of Richmond in August following 14" of rain in eight hours.
2006	Tazewell County	A severe storm with very intense rain. Intense enough to help produce a landslide near a pipeline construction project near the town of Tannersville, VA. The landslide blocked sections of Freestone Valley Road with mud up to 3 inches deep.
2008	Giles County	Showers and thunderstorms produced enough rain to cause a mudslide that blocked Highway 42. Property damage was estimated at $10,000
2008	Alleghany County	Due to a series of thunderstorms and rainfall, a rock slide occurred on Route 220 just north of the City of Covington. No property damage estimates were reported.
2013	Giles County	Storms along the southwest Virginia mountains created a mudslide along Rouge 100 and Meadows Road near Staffordsville.
2015	Grayson County	Slow moving storms across central and southern Grayson County produced rainfall of one to three inches with isolated amounts up to five inches. Mudslides were reported in the area around Peach Bottom Road.

Probability

Landslide probability is highly site-specific, and cannot be accurately characterized on a statewide basis, except in the most general sense. Relative risk ranking is intended only for general comparison to the other hazards that impact Virginia.

The landslide hazard is dependent on the amount of water present to mobilize the slide, the total size of the slide, and the amount of development in the area that could potentially be impacted. Landslides are more common in areas with steeper slopes (generally greater than 22 degrees) and in poorly drained soils. Some areas that are generally prone to landslides include old landslide sites, base of slopes, base of minor drainage hollows, base or top of old fill slope, base or top of a steep cut slope, and developed hillsides where leach field septic systems are used [6].

A hazard map was developed by the USGS based on the 1995 Madison County event. This report states the mapping procedures applicability to other parts of the Blue Ridge. Generally, the Commonwealth can expect to see a series of damaging debris flows every 10-15 years somewhere in the state. Recurrence for a debris-flow event, in a small area, can be one event every 3,000 to 4,000 years (0.03 – 0.025 percent annual chance) for Nelson County[7]. The drainage needs to be charged with soil material that could potentially fail. These intervals will decrease when considering larger geographic areas.

Impact and Vulnerability

Landslides can cause serious damage to highways, buildings, homes, and other structures that support a wide range of economies and activities. Landslides commonly coincide with other natural disasters. Expansion of urban development contributes to greater risk of damage by landslides.

The USGS recognizes six major impacts caused by landslides:

1. Causes damage in all 50 states, Puerto Rico, and the US Virgin Islands;
2. Costs $3.5 billion per year, in 2005 dollars, in damage repair;
3. Causes between 25 and 50 deaths in the United States annually;
4. Reduces real estate values and tourist revenue;
5. Leads to lost human, industrial, agricultural, and forest productivity; and
6. Causes damage to the natural environment[8].

Risk

Because the data are highly generalized, owing to the small scale and the scarcity of precise landslide information for much of the country, it is unsuitable for local planning or actual site selection. Without well-established occurrence probabilities, true risk and annualized dollar losses cannot be estimated. However, a rough estimate of financial impact can be developed based on the NCEI *Storm Events Database*, although such an estimate is subject to the biases and inconsistencies present in that data. For the 18-year period from 1998 through 2016, NCEI reports an annualized average of damaged of $8,333 per year[9].

The best available landslide data is the USGS *Landslide Overview Map of the Coterminous United States*. This dataset shows areas in the US where large numbers of landslides have occurred and areas which are susceptible to landslides. This dataset is a digital representation of USGS Open-File Report 97-289, which is a PDF version of the 1997 USGS Digital Representation of Landslide Overview Map (scale 1:4,000,000). The map classifies the major physical subdivision of the US and assesses the vulnerability based on subdivision characteristics. Figure 3.13-1 shows the areas that may be susceptible to landslides, with risk indicated[10].

This assessment focuses on areas that may be susceptible to landslides and are likely to occur based on past incidence. The assigning of any area to the lowest incidence or susceptibility category should not be construed to mean that no landslides exist or that no areas are susceptible to landslides. Even areas in the lowest category may contain landslides unknown to the compilers or have an incidence of less than 1.5 percent. In general, the possibility is great that a lot more landslides than indicated exist in any given map area (except for the highest category),

owing to the overall scarcity of landslide information for many parts of the country. Moreover, many published special-purpose geologic maps do not show landslides, even where they are known to exist[11].

The USGS divides landslide risk into six categories. These six categories were grouped into three, broader categories to be used for the risk analysis and ranking; geographic extent is based on these groupings. These categories include:

High Risk

1. High susceptibility to landsliding and moderate incidence.
2. High susceptibility to landsliding and low incidence.
3. High landslide incidence (more than 15 percent of the area is involved in landsliding).

Moderate Risk

4. Moderate susceptibility to landsliding and low incidence.
5. Moderate landslide incidence (1.5 - 15 percent of the area is involved in landsliding).

Low Risk

6. Low landslide incidence (less than 1.5 percent of the area is involved in landsliding)[12].

Figure 3.13-1: Landslide Incidence and Susceptibility Explanation[13]

EXPLANATION

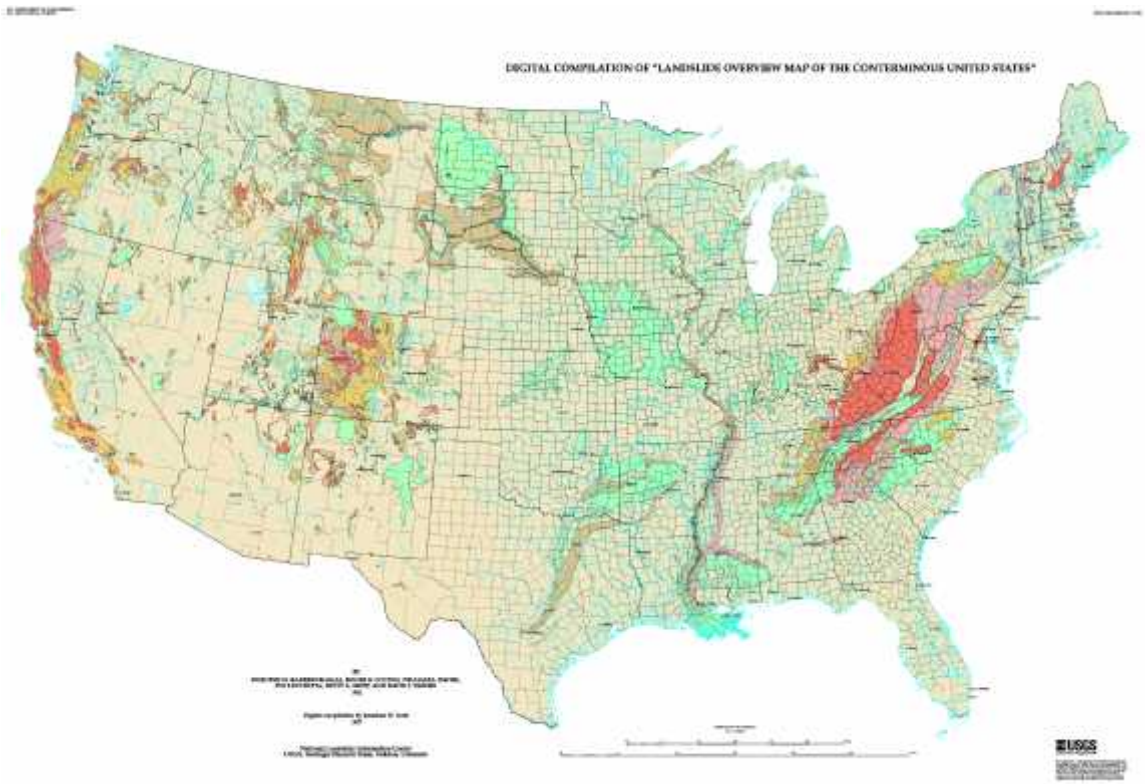
LANDSLIDE INCIDENCE

- Low (less than 1.5% of area involved)
- Moderate (1.5%-15% of area involved)
- High (greater than 15% of area involved)

LANDSLIDE SUSCEPTIBILITY/INCIDENCE

- Moderate susceptibility/low incidence
- High susceptibility/low incidence
- High susceptibility/moderate incidence

Susceptibility not indicated where same or lower than incidence. Susceptibility to landsliding was defined as the probable degree of response of [the areal] rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated.



The six categories were grouped into High (categories 1-3), Medium (categories 4 – 5), and Low (category 6) to assess the risk to state facilities, critical facilities and jurisdictions.

State Facility Risk

To determine which facilities were at risk for landslide, the state facilities were intersected with the USGS Landslide Incidence and Susceptibility layer, and the dominant risk category was then assigned to the facilities. The results of this analysis indicate 3,516 buildings are in regions with relatively high landslide risk, and 2,372 are in areas with relatively moderate landslide risk. Table 3.13-2 shows the distribution of building risk for state facilities. Annualized loss estimates were not calculated for state facilities due to the scale of available landslide mapping, the lack of building detail data available (including valuation), and the lack of probabilities of future occurrences.

Table 3.13-2: Number of State Facilities Located in Landslide Risk Zone, by Agency

Agency	Number of Buildings in Landslide Risk Area	Number of Buildings in High Landslide Risk Area	Number of Buildings in Moderate Landslide Risk Area
Virginia Department of Alcoholic Beverage Control	19	13	6
Virginia Department of Behavioral Health and Development Services	227	180	47
Virginia Department of Criminal Justice Services	1	0	1
Virginia Department of Conservation and Recreation	844	427	417
Virginia Department of Environmental Quality	2	0	2
Virginia Department of Forensic Science	5	3	2
Virginia Department of Game and Inland Fisheries	180	92	88
Virginia Department of General Services	76	73	3
Virginia Department of Historic Resources	5	0	5
Virginia Department of Juvenile Justice	36	36	0
Virginia Department of Military Affairs	76	54	22
Virginia Department of Mines, Minerals, and Energy	4	0	4
Virginia Department of Motor Vehicles	16	10	6
Virginia Department of Corrections	677	408	269
Virginia Department of Forestry	170	113	57
Virginia Department of Veterans Services	6	2	4
George Mason University	7	7	0
James Madison University	4	2	2
University of Mary Washington	6	6	0
Jamestown-Yorktown Foundation	11	0	11
Northern Virginia Community College	2	2	0

Agency	Number of Buildings in Landslide Risk Area	Number of Buildings in High Landslide Risk Area	Number of Buildings in Moderate Landslide Risk Area
Radford University	62	0	62
Southwest Virginia Higher Education Center	2	0	2
University of Virginia	535	513	22
Virginia Community College System	174	73	101
Virginia Commonwealth University	158	158	0
Virginia Department of Agriculture and Consumer Services	11	6	5
Virginia Department of Health	2	0	2
Virginia Department of Transportation	1,685	1,031	654
Virginia Employment Commission	7	7	0
Virginia Military Institute	18	18	0
Virginia Polytechnic Institute and State University (Virginia Tech)	624	151	473
Virginia Department for the Blind and Vision Impaired Home	4	4	0
Virginia Port Authority	7	0	7
Virginia State Police	100	50	50
Woodrow Wilson Rehabilitation Center	39	0	39
Other Agencies	284	276	8
Total:	**5,888**	**3,516**	**2,372**

Critical Facility Risk

Risk for critical facilities was calculated in the same fashion described above for state facilities. Approximately eight percent of state-owned assets are critical facilities in regions with a moderate or high risk of landslide. Table 3.13-3 shows the number of critical facilities identified in moderate or high risk landslide areas, by risk level and use. Utilities, fuel service/storage, and hazardous materials represent many critical facilities in potential risk areas. Annualized loss estimates were not calculated for critical facilities due to the scale of available landslide mapping, limited information on mapped critical facilities (including valuation data), and the lack of probabilities of future occurrences.

Table 3.13-3: Critical Facilities in Landslide Risk Areas

Critical Facility Use	Number in High Risk Areas	Number in Moderate Risk Areas
Airfield	4	5
Animal Health	4	12

Critical Facility Use	Number in High Risk Areas	Number in Moderate Risk Areas
Armory	11	10
Childcare	5	0
Communications	18	12
Emergency Operations Center	0	1
Fire Service/Support/Suppression	8	9
Food Service/Storage	12	10
Fuel Storage/Delivery	179	96
Hazardous Materials Storage	127	78
Medical Services/Support/EMS	43	18
Public Safety/Security	51	27
Research	37	70
Special Populations Housing	9	3
Utilities	178	127
Total:	**686**	**467**

Landslide Risk to Energy Pipelines

Soil movement associated with landslides can destabilize the structural supports of pipelines, possibly leading to pipeline ruptures. In Virginia, landslides can be expected to occur in conjunction with other hazard events such as flooding or earthquake, which also pose independent risks to pipelines (see section 3.9 and 3.10).

Future Conditions Considerations

Different phenomena influence the stability of slopes and cause landslides, including precipitation, snow melt, temperature changes, earthquakes, and volcanic activity. Climate and its variations influence some of these phenomena, chiefly precipitation and temperature. It is therefore expected that climate (and its changes) influences slope stability at different temporal and geographical scales[14].

That climate changes affect the stability of natural and engineered slopes, and have consequences on landslides, is clear. Less clear are the details of those consequences - the type, extent, magnitude, and direction of the changes in the stability conditions, and on the location, abundance, activity and frequency of landslides in response to the projected climate changes. Climate and landslides act at only partially overlapping spatial and temporal scales, complicating the evaluation of the climate impacts on landslides[15]. How changes in the climate of Virginia will impact landslides cannot be determined now; more specific research is required, as is a longer timeline of data.

Changing climate will certainly impact landslides in Virginia, possibly through increasing the frequency or the severity of the events – possibly both simultaneously. This makes a detailed land risk study necessary, to determine the specific potential impacts to Virginia.

Jurisdictional Risk

The hazard ranking for landslide is based on events reported in the NCEI *Storm Events Database* and a generalized geographic extent rating developed from the USGS landslide susceptibility and incidence. Ranking inputs for landslide were very limited because of having only four historical landslide events available from the NCEI database. To be able to include landslide in the risk assessment some general assumptions were made; geographical extent was the primary basis for establishing risk and was calculated as a percent of the jurisdictional area in high risk. In lieu of probability of future occurrence, areas with higher landslide risk were assumed to be at greater risk. These parameters are illustrated in Table 3.13-4, along with the total ranking. Most the Commonwealth is in the lower risk categories.

Currently the NCEI database is the most standardized and comprehensive database for all the hazards discussed in this plan. This database is limited in the amount of data that is available for geological hazards. The limitations are evident in the ranking and when compared to the known historical events; Hurricane Camille in 1969 resulted in landslides that killed 150 people but this event is not within the period of record of the NCEI database. See section 3.5 for more information on the methodology used for ranking hazards.

Table 3.13-4 shows the relative ranking results for landslide. The following communities are in high and medium-high risk zones:

- City of Charlottesville
- City of Alexandria
- City of Hopewell
- City of Lynchburg
- Buchanan County
- Albemarle County
- Loudoun County
- Greene County
- Franklin County
- Amherst County
- Bedford County
- Campbell County
- City of Richmond
- Carroll County
- Wise County
- Henry County
- City of Norton
- City of Galax
- City of Martinsville
- City of Covington
- Madison County
- Nelson County

With future growth, various non-structural methods, such as zoning and grading ordinances, as well as structural methods, would have to be analyzed in terms of being cost-effective alternatives. Zoning and grading ordinances to avoid building in areas of potential hazard or to regulate construction to minimize potential for landsliding is one non-structural method to reduce the likely consequences of debris flows. For example, Loudoun County adopted a zoning ordinance preventing the development of building sites with steep slopes along the Blue Ridge (defined in the ordinance as exceeding a 15 percent grade, equivalent to an 8-degree slope) which substantially reduces the hazards of landslides and debris flows within that area[16].

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

None of the 20 local plans provided loss estimates for this hazard. Of the plans that provided a general description of landslides, some of them referred to the USGS landslide susceptibility and incidence mapping. The consensus in the local plans is that there is no definitive way to estimate potential damages due to landslides at the local level with available local resources and data.

Comparison with Local Ranking

Lenowisco PDC and Cumberland Plateau PDC both ranked landslide as a medium-high hazard. Eight plans ranked landslide as a low hazard, the remaining ten plans did not provide a rank for this hazard, resulting in a local plan average of low for landslide. The 2018 statewide analysis has ranked landslide as medium-low risk. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). Lenowisco PDC and Cumberland Plateau PDC mentioned that the densely populated areas in the PDC are in areas with a more gradual slope and therefore the widespread damages due to landslides would be limited in the those developed areas. Changes in development would most likely have an impact on loss estimates if there was an established method for calculating loss due to land sliding.

Table 3.13-4: Landslide Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Low	Low	Low	Low	Medium-Low
Albemarle	Medium-High	Medium	Low	Low	Low	Low	Medium-High	Medium-Low
Alexandria, City of	Medium-High	High	Low	Low	Low	Low	Medium-High	Medium
Alleghany	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Amelia	Low	Low	Low	Low	Low	Low	Low	Low
Amherst	Medium	Medium	Low	Low	Low	Low	Medium-High	Medium-Low
Appomattox	Low	Low	Low	Low	Low	Low	Low	Low
Arlington	High	High	Low	Low	Low	Low	Low	Medium-Low
Augusta	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Bath	Low	Low	Low	Low	Low	Low	Low	Low
Bedford	Medium-High	Medium	Low	Low	Low	Low	Medium-High	Medium-Low
Bland	Low	Low	Low	Low	Low	Low	Low	Low
Botetourt	Medium	Medium	Low	Low	Low	Low	Low	Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Brunswick	Medium	Low	Low	Low	Low	Low	Low	Low
Buchanan	Medium	Low	Low	Low	Low	Medium	High	Medium-Low
Buckingham	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Campbell	Medium	Medium	Low	Low	Low	Low	Medium-High	Medium-Low
Caroline	Medium	Low	Low	Low	Low	Low	Low	Low
Carroll	Medium	Medium	Low	Low	Low	Low	Medium-High	Medium-Low
Charles City	Low	Low	Low	Low	Low	Low	Low	Low
Charlotte	Low	Low	Low	Low	Low	Low	Low	Low
Charlottesville, City of	Medium	High	Low	Low	Low	Low	Medium-High	Medium-Low
Chesapeake, City of	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Chesterfield	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Clarke	Low	Medium	Low	Low	Low	Low	Low	Low
Colonial Heights, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Covington, City of	Low	Medium-High	Low	Low	Low	Low	Medium-High	Medium-Low
Craig	Low	Low	Low	Low	Low	Low	Low	Low
Culpeper	Medium	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Cumberland	Low	Low	Low	Low	Low	Low	Low	Low
Danville, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Dickenson	Low	Low	Low	Low	Low	Low	Low	Low
Dinwiddie	Medium	Low	Low	Low	Low	Low	Low	Low
Emporia	Low	Medium-High	Low	Low	Low	Low	Low	Low
Essex	Low	Low	Low	Low	Low	Low	Low	Low
Fairfax	High	High	Low	Low	Low	Low	Low	Medium-Low
Fairfax, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Falls Church, City of	Low	High	Low	Low	Low	Low	Low	Low
Fauquier	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Floyd	Low	Low	Low	Low	Low	Low	Low	Low
Fluvanna	Medium	Medium	Low	Low	Low	Low	Low	Low
Franklin	Medium	Medium	Low	Low	Low	Low	Medium-High	Low
Franklin, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Frederick	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Fredericksburg, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Galax, City of	Low	Medium-High	Low	Low	Low	Low	Medium-High	Medium-Low
Giles	Low	Low	Low	Low	Low	Medium-Low	Medium	Low
Gloucester	Medium	Medium	Low	Low	Low	Low	Low	Low
Goochland	Medium	Medium	Low	Low	Low	Low	Low	Low
Grayson	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Greene	Medium	Medium	Low	Low	Low	Low	Medium-High	Medium-Low
Greensville	Low	Low	Low	Low	Low	Low	Low	Low
Halifax	Medium	Low	Low	Low	Low	Low	Low	Low
Hampton, City of	Medium-High	High	Low	Low	Low	Low	Low	Low
Hanover	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Harrisonburg, City of	Medium	High	Low	Low	Low	Low	Medium	Medium-Low
Henrico	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Henry	Medium	Medium	Low	Low	Low	Low	Medium-High	Medium-Low
Highland	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Hopewell, City of	Medium	High	Low	Low	Low	Low	Medium-High	Medium-Low
Isle of Wight	Medium	Medium	Low	Low	Low	Low	Low	Low
James City	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
King and Queen	Low	Low	Low	Low	Low	Low	Low	Low
King George	Medium	Medium	Low	Low	Low	Medium	Medium-Low	Medium-Low
King William	Low	Low	Low	Low	Low	Low	Low	Low
Lancaster	Low	Medium	Low	Low	Low	Low	Low	Low
Lee	Medium	Low	Low	Low	Low	Low	Low	Low
Lexington, City of	Low	High	Low	Low	Low	Low	Low	Low
Loudoun	High	Medium-High	Low	Low	Low	Low	Medium-High	Medium-Low
Louisa	Medium	Medium	Low	Low	Low	Low	Low	Low
Lunenburg	Low	Low	Low	Low	Low	Low	Low	Low
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Low	Medium-High	Medium-Low
Madison	Low	Low	Low	Low	Low	Medium	High	Medium-Low
Manassas, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Manassas Park, City of	Low	High	Low	Low	Low	Low	Low	Low
Martinsville, City of	Low	Medium-High	Low	Low	Low	Low	Medium-High	Medium-Low
Mathews	Low	Medium	Low	Low	Low	Low	Low	Low
Mecklenburg	Medium	Low	Low	Low	Low	Low	Low	Low
Middlesex	Low	Medium	Low	Low	Low	Low	Low	Low
Montgomery	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Nelson	Low	Low	Low	Low	Low	Medium	High	Medium-Low
New Kent	Low	Medium	Low	Low	Low	Low	Low	Low
Newport News, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Norfolk, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Northampton	Low	Medium	Low	Low	Low	Low	Low	Low
Northumberland	Low	Low	Low	Low	Low	Low	Low	Low
Norton	Low	Medium-High	Low	Low	Low	Low	Medium-High	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Nottoway	Low	Low	Low	Low	Low	Low	Low	Low
Orange	Medium	Medium	Low	Low	Low	Low	Low	Low
Page	Medium	Medium	Low	Low	Low	Low	Low	Low
Patrick	Medium	Low	Low	Low	Low	Low	Low	Low
Petersburg, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Pittsylvania	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Poquoson	Low	Medium-High	Low	Low	Low	Low	Low	Low
Portsmouth, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Powhatan	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince Edward	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince George	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince William	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Pulaski	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Radford, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Rappahannock	Low	Low	Low	Low	Low	Low	Low	Low
Richmond	Low	Low	Low	Low	Low	Low	Medium-High	Low
Richmond, City of	High	High	Low	Low	Low	Medium-Low	Low	Medium-Low
Roanoke	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Roanoke, City of	Medium-High	High	Low	Low	Low	Low	Medium	Medium-Low
Rockbridge	Medium	Low	Low	Low	Low	Low	Medium	Low
Rockingham	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Russell	Medium	Low	Low	Low	Low	Low	Low	Low
Salem, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Scott	Medium	Low	Low	Low	Low	Low	Low	Low
Shenandoah	Medium	Medium	Low	Low	Low	Low	Low	Low
Smyth	Medium	Medium	Low	Low	Low	Low	Low	Low
Southampton	Low	Low	Low	Low	Low	Low	Low	Low
Spotsylvania	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Stafford	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Staunton, City of	Medium	Medium-High	Low	Low	Low	Medium-Low	Low	Medium-Low
Suffolk	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Surry	Low	Low	Low	Low	Low	Low	Low	Low
Sussex	Low	Low	Low	Low	Low	Low	Low	Low
Tazewell	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low
Virginia Beach, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Warren	Medium	Medium	Low	Low	Low	Low	Low	Low
Washington	Medium	Medium	Low	Low	Low	Low	Low	Low
Waynesboro, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Westmoreland	Low	Medium	Low	Low	Low	Low	Low	Low
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Winchester, City of	Medium	High	Low	Low	Low	Low	Medium	Medium-Low
Wise	Medium	Medium	Low	Low	Low	Low	Medium-High	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Wythe	Medium	Medium	Low	Low	Low	Low	Low	Low
York	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low

For the 2018 plan, the overall hazard ranking for landslide is medium-low.

Table 3.13-5: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts are expected to be moderate to catastrophic for the impacted area, the worst disaster the Commonwealth has experienced is the landslides associated with Tropical Storm Camille in 1969, 150 deaths.
Health and Safety of Response Personnel	Localized impacts could be serious as local responders are working within the impacted area, if they live within the impacted area then they may be displaced or isolated for an extended period of time.
Continuity of Operations	Damage to facilities/personnel in the area of the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure in the area of the event could be severe.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be severe for the impacted areas. With a high potential for debris, HAZMAT may be an issue.
Economic and Financial Condition	Local economic and financial conditions may be impacted for a long period of time depending on duration and geographical area of the event, as well as the size and capabilities of the local jurisdiction.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient. Local and state land development policies may be in question.

Endnotes

[1] Virginia Department of Mines, Minerals, and Energy. *Landslides.* Retrieved 05.10.17 from https://www.dmme.virginia.gov/dgmr/landslides.shtml
[2] Virginia Department of Mines, Minerals, and Energy. *Landslides.* Retrieved 05.10.17 from https://www.dmme.virginia.gov/dgmr/landslides.shtml
[3] US Geological Surbey. Fact Sheet: FS-159-96: *Debris-Flow Hazards in the Blue Ridge of Virginia*. Verified 05.10.17 from https://pubs.usgs.gov/fs/1996/0159/report.pdf
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Section 3.14: Land Subsidence

Description

Land subsidence is the sinking or lowering of the land surface. Most land subsidence in the US is caused by human activities. Two well-studied cases of land subsidence are in the Houston-Galveston, Texas, area and the Santa Clara Valley, California. Land sank by as much as three meters over 50 years because of intensive groundwater withdrawals in the two areas, as well as petroleum extraction in Texas, resulting in increased coastal flooding. Regional authorities were established in the two areas to manage water use and land subsidence. The regional authorities set up monitoring networks and enlisted scientists to study the problem. Ultimately, the communities adopted new water-management practices to prevent land subsidence, including relocating groundwater withdrawals away from the coast, substituting surface water for groundwater supplies, and increasing aquifer recharge. In the Santa Clara Valley, subsidence has mostly been stopped and, in the Houston-Galveston area, subsidence has been slowed, particularly along vulnerable shorelines[1].

Rates and locations of land subsidence change over time so accurate measurements and predictive tools are needed to improve understanding of land subsidence. Although rates of land subsidence are not as high on the Atlantic Coast as they have been in the Houston- Galveston area or the Santa Clara Valley, land subsidence is important because of the low-lying topography and susceptibility to sea-level rise in the southern Chesapeake Bay region[2].

While land subsidence is possible in many areas, this assessment will focus on the southern Chesapeake Bay and Hampton Roads area.

Historic Occurrence

To date, there have been no federal disaster declarations or NCEI recorded events for land subsidence-related events. Land subsidence is a site-specific hazard. Currently there is no comprehensive, long-term record of past events in Virginia. There is significant documentation of the hazard occurring in the southern Chesapeake Bay/Hampton Roads area of the state.

The southern Chesapeake Bay region is experiencing land subsidence and rising water levels. Land subsidence has been observed in the area since the 1940s, at rates of 1.1 to 4.8 millimeters annually. The subsidence continues to the present day, and helps to explain why the area has one of the highest rates of sea level rise on the US Atlantic Coast. Studies of the available data indicate that land subsidence is responsible for more than half of the observed rise in sea levels in the area[3].

The aquifer system in the region has been compacted by extensive groundwater pumping. Rates of 1.5 to 3.7 millimeters per year have been observed. This compaction accounts for

approximately half of the observed subsidence in the region. The flexing of the Earth's crust in response to glacier formation and melting is another likely contributor to the subsidence in the region[4].

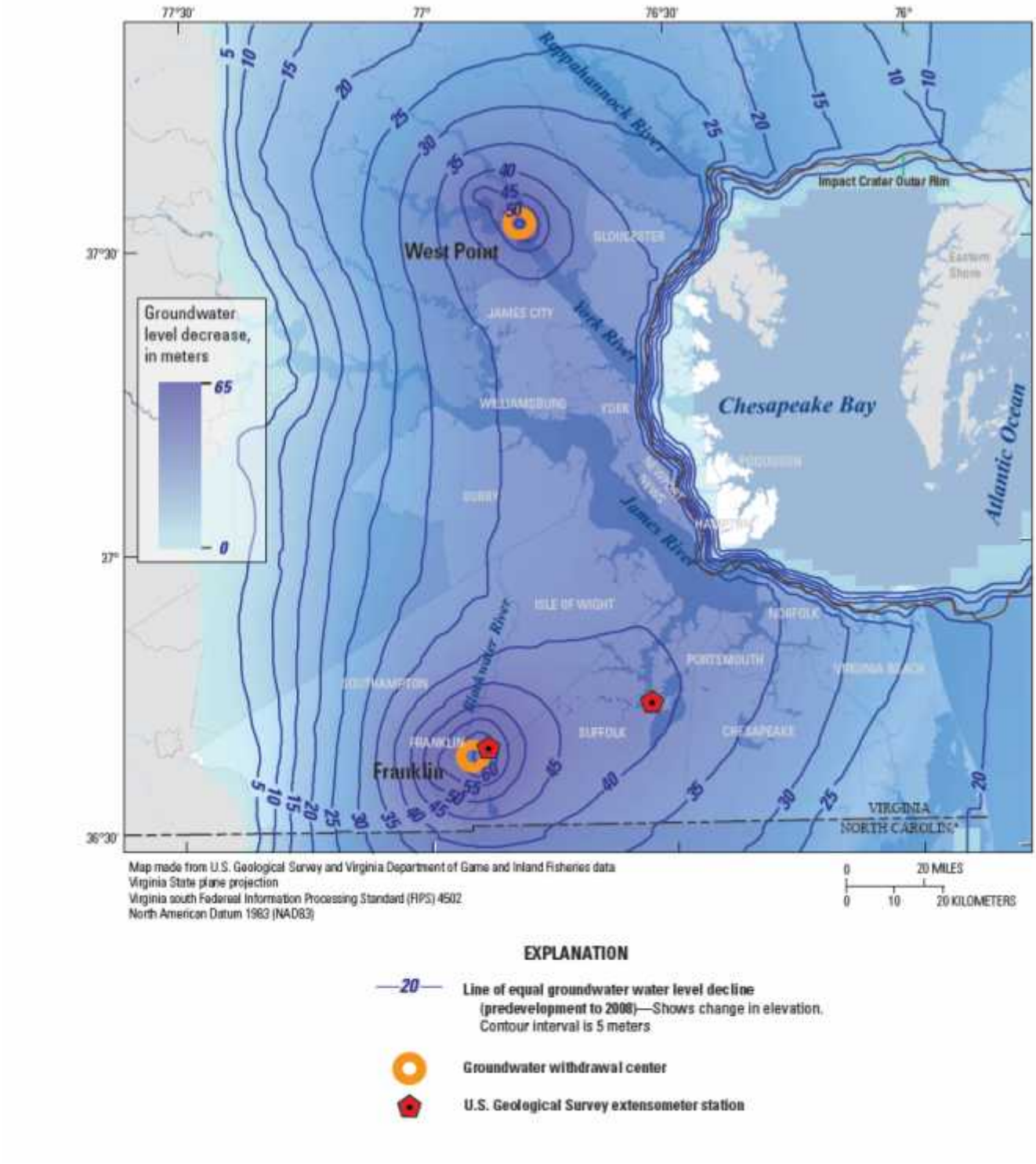
Risk Assessment

From the USGS report *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region:*

> As relative sea levels rise, shorelines retreat and the magnitude and frequency of near-shore coastal flooding increase. Although land subsidence can be slow, its effects accumulate over time. This has been an expensive problem in the Houston-Galveston area and the Santa Clara Valley (Galloway and others, 1999) and likely contributes to current flooding problems in the southern Chesapeake Bay region. Analysis by McFarlane (2012) found that between 59,000 and 176,000 residents living near the shores of the southern Chesapeake Bay could be either permanently inundated or regularly flooded by 2100. This estimate was based on 2010 census data, using the spring high-tide as a reference elevation and assuming a 1-m relative sea-level rise. Damage to personal property was estimated to be $9 billion to $26 billion, and 120,000 acres of ecologically valuable land could be inundated or regularly flooded, under these same assumptions. Historic and cultural resources are also vulnerable to increased flooding from relative sea-level rise in the southern Chesapeake Bay, particularly at shoreline sites near tidal water, such as the 17th century historic Jamestown site.
>
> Land subsidence can also increase flooding in areas away from the coast. Low-lying areas, such as the Blackwater River Basin (fig. 2), can be subject to increased flooding as the land sinks. Locations along the Blackwater River in the city of Franklin and the counties of Isle of Wight and Southampton have experienced large floods in recent years (fig. 5; Federal Emergency Management Agency, 2002). Land subsidence may be altering the topographic gradient that drives the flow of the river and possibly contributing to the flooding[5].

Figure 3.14-1 illustrates the groundwater water-level decreases in the southern Chesapeake Bay region between 1900 and 2008.

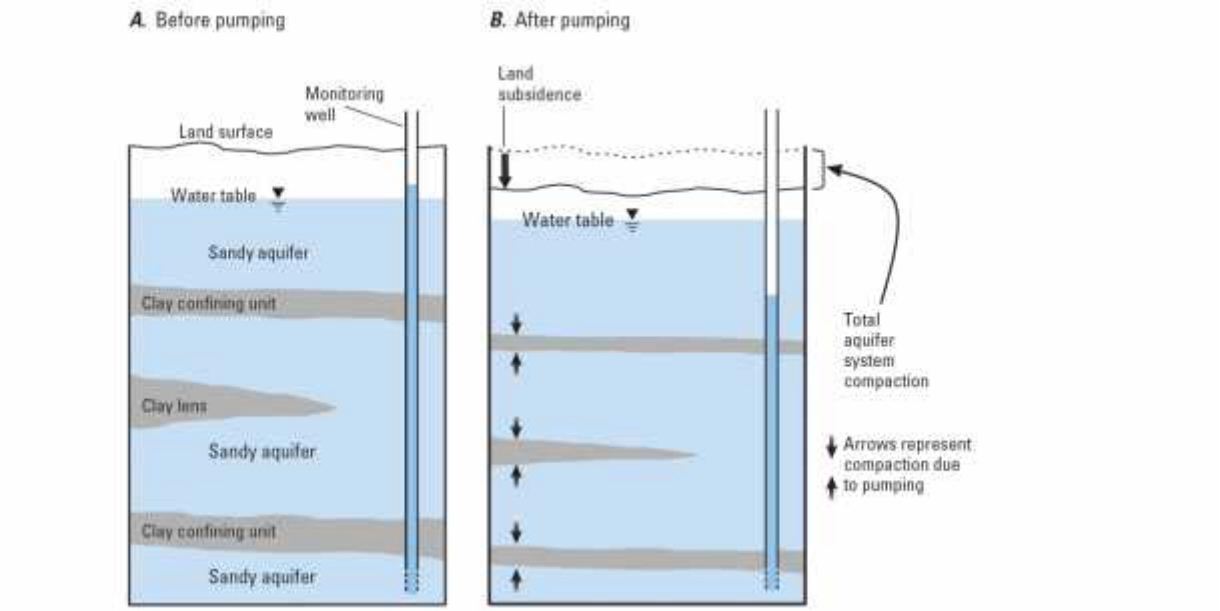
Figure 3.14-1: Groundwater Water-Level Decreases from 1900-2008 in the Southern Chesapeake Bay Region[6]



When groundwater is pumped out of an aquifer, pressure decreases. The pressure change is measured by water levels in wells decreasing as aquifer-system pressure decreases. This situation is happening and has been happening over most of the southern Chesapeake Bay region. The greatest decreases in pressure have been measured near the pumping centers of Franklin and West Point. As water levels decrease, the aquifer system compacts, causing the land on the surface to subside[7]. This phenomenon is illustrated in Figure 3-14.2.

Water levels have decreased over the entire Virginia Coastal Plain in the Potomac Aquifer, which is the aquifer that supplies approximately three-quarters of the groundwater withdrawn from the Virginia Coastal Plan aquifer system. It is also the deepest and the thickest aquifer in the southern Chesapeake Bay region[8].

Figure 3.14-2: Aquifer-System Compaction Caused by Groundwater Withdrawals[9]



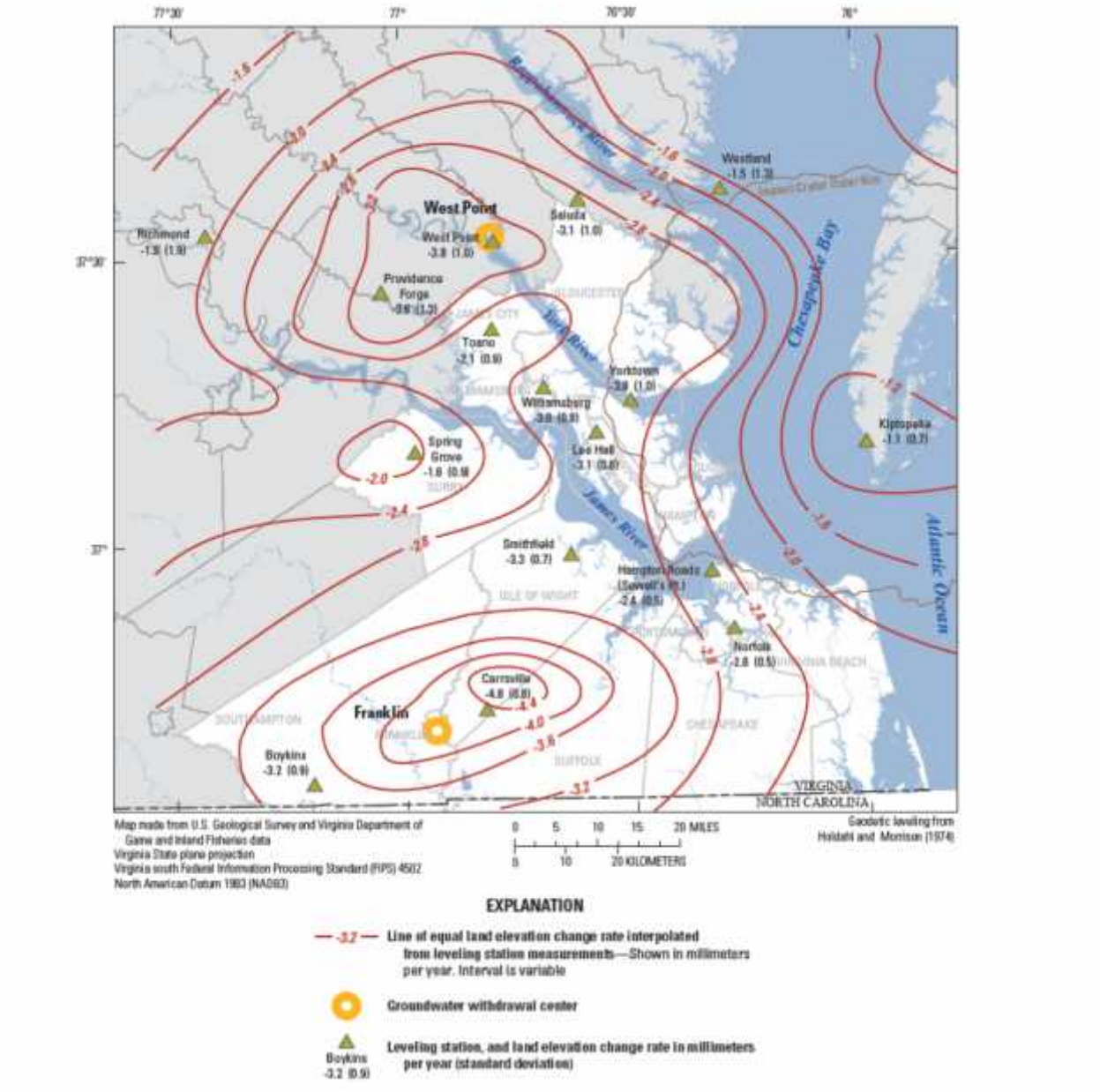
Probability

The probability of land subsidence cannot be expressed in terms of specific return periods or recurrence intervals as it can be for other hazards. For the Hampton Roads area, the probability of land subsidence is high, given that this is a continuous phenomenon that is unlikely to cease soon.

Land subsidence in the Hampton Roads area was first documented in 1940. Repeated surveys between 1940 and 1971 documented that land surfaces across the region were sinking at an average rate of 2.8 millimeters per year. In 2013, the area was re-measured, and average rates

were found to be 3.1 millimeters per year[10]. Figure 3.14-3 provides a visual representation of the 1940-1971 rates of subsidence.

Figure 3.14-3: Land Elevation Change Rates from 1940 through 1971[11]



Impact and Vulnerability

Subsidence has the potential to negatively impact assets and residents. The Hampton Roads area has already subject to flooding, both from rainfall and from coastal storms. Any further decrease in elevation would only serve to exacerbate these conditions. Subsidence can damage wetland and coastal marsh ecosystems by exposing shorelines to increased wave action and washovers.

Damage to infrastructure in the area – such as buildings, bridges, and pipelines – can be caused by relative groundwater rise or land settling. Storm and wastewater sewers in urban areas may be vulnerable because subsidence can alter the flow through the sewers, causing increase flooding and more frequent sewer discharge from overflows[12].

Risk

Risk, strictly defined as probability multiplied by impact, cannot be fully estimated for land subsidence due to the lack of historical data and details of state assets, including valuations. To assess risk, this assessment focused on the state assets located in the southern Chesapeake Bay / Hampton Roads region.

State Facility Risk

In order to determine which facilities are at risk for land subsidence, the state facilities in the Hampton Roads / southern Chesapeake Bay region were examined. The results of this analysis indicate 1,975 buildings at risk from land subsidence. Table 3.14-1 shows the distribution of building risk for state facilities. Annualized loss estimates were not calculated for state facilities due to the lack of building detail data available (including valuation), and the lack of probabilities of future occurrences.

Table 3.14-1: Number of State Facilities Located in Land Subsidence Areas, by Agency

Agency	Number of Buildings in Land Subsidence Areas
Virginia Department of Alcoholic Beverage Control	8
Virginia Department of Behavioral Health and Development Services	69
Virginia Department of Conservation and Recreation	188
Virginia Department of Emergency Management	40
Virginia Department of Environmental Quality	1
Virginia Department of Forensic Science	2
Virginia Department of Game and Inland Fisheries	34
Virginia Department of Military Affairs	194
Virginia Department of Motor Vehicles	9
Virginia Department of Corrections	102
Virginia Department of Forestry	19
Virginia Department of Veterans Services	7
Jamestown-Yorktown Foundation	31

Agency	Number of Buildings in Land Subsidence Areas
Christopher Newport University	42
Norfolk State University	45
Old Dominion University	113
Tidewater Community College	12
Virginia Community College System	52
Virginia Department of Agriculture and Consumer Services	3
Virginia Central Western Massachusetts Healthcare System	552
Virginia Department of Transportation	269
Virginia Employment Commission	6
Virginia Institute of Marine Science	83
Virginia Polytechnic Institute and State University (Virginia Tech)	49
Virginia Port Authority	69
Virginia State Police	18
Other Agencies	33
Total:	**1,975**

Critical Facility Risk

Risk for critical facilities was calculated in the same fashion described above for state facilities. Approximately one percent of state-owned assets are critical facilities in the Hampton Roads / southern Chesapeake Bay region. Table 3.14-2 shows the number of critical facilities identified in the area. Utilities, fuel service/storage, and hazardous materials represent many critical facilities in potential risk areas. Annualized loss estimates were not calculated for critical facilities due to the limited information on mapped critical facilities (including valuation data), and the lack of probabilities of future occurrences.

Table 3.14-2: Critical Facilities in Land Subsidence Risk Area

Critical Facility Use	Number in Land Subsidence Area
Airfield	3
Animal Health	1
Armory	6
Childcare	2
Communications	5
Fire Service/Support/Suppression	2

Critical Facility Use	Number in Land Subsidence Area
Food Service/Storage	14
Fuel Storage/Delivery	49
Hazardous Materials Storage	33
Medical Services/Support/EMS	12
Public Safety/Security	14
Research	21
Special Populations/Housing	1
Utilities	68
Total:	**231**

Land Subsidence Risk to Energy Pipelines

Soil movement associated with land subsidence can destabilize the structural supports of pipelines, possibly leading to pipeline ruptures.

Future Conditions Considerations

From *Chesapeake Bay Land Subsidence and Sea Level Change: An Evaluation of Past and Present Trends and Future Outlook:*

> Linear trend analysis of monthly mean sea level (mmsl) data from ten Chesapeake Bay water level stations with a common time span have provided insight into temporal and spatial differences in relative sea level rise (RSLR) with approximately the same confidence interval at each station after decadal signal extraction (DSE). Time-segment comparisons indicate small increases in RSLR at four of five Chesapeake Bay stations with data arranged in two periods of equal, non-overlapping spans: 1944-1975 and 1976-2007. Although none of the increases are statistically significant, the methodology used here (DSE analysis) is still sensitive to recent changes on the order of ±0.05 mm/yr. Excluding Washington, DC (WASH), which has significant serial correlation for this period, 1976-2007 RSLR rates at nine stations show an average increase of 0.10 mm/yr compared to NOAA RSLR rates for the same nine stations as reported in Zervas (2009). The 1976-2007 RSLR rate at Sewells Point (SWPT) as determined in this study, for example, is 4.52 ± 0.66 mm/yr (Table 5) compared to 4.44 ± 0.27 mm/yr reported by Zervas (2009) for the 1927-2006 period at SWPT, an increase of 0.08 mm/yr above the NOAA rate[13].

Jurisdictional Risk

To compare different hazards based on a common system, inputs for land subsidence were very limited as a result of no recorded NCEI events. To be able to include land subsidence in the risk assessment some general assumptions were made. Geographical Extent, using USGS land subsidence topography maps, was the primary basis for establishing risk. In lieu of probability of

future occurrence, areas with more land subsidence were assumed to be at greater risk, and were assigned a higher GE ranking than other jurisdictions.
These parameters in the land subsidence risk assessment are illustrated in Table 3.14-3, along with the total ranking. There are currently no land subsidence related records in NCEI; as a result, the lowest ranking score (1) was assigned to the annualized data for population vulnerability, events, damages, and fatalities and injuries to be able to compare land subsidence to the other hazards, as described in section 3.5.

Jurisdictions ranked as medium (highest rank) risk for their jurisdiction include the jurisdictions within the Central Shenandoah Valley Planning District Commission and the Hampton Roads Planning District Commission. Both combined land subsidence with other hazards.

Local Plan Risk Assessment
Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.
The three local plans that included land subsidence did not provide loss estimates for the hazard. Of the plans that provided a general description of land subsidence, some of them intersected US Census data with the USGS karst zones to estimate the population located within a land subsidence zone. The consensus in the local plan is that there is no way to estimate potential damages.

Comparison with Local Ranking
No local plans ranked land subsidence as a high hazard. Central Shenandoah Valley and Hampton Roads Planning District Commissions both ranked land subsidence as medium.

Changes in Development
Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). A few plans exclusively noted that they have zoning ordinances related to sinkhole development or they have mitigation actions to address these in the future.

Table 3.14-3: Land Subsidence Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Low	Medium	Low	Low	Low	Low	Low	Low
Albemarle	Low	Medium	Low	Low	Low	Low	Low	Low
Alexandria, City of	Low	High	Low	Low	Low	Low	Low	Low
Alleghany	Low	Low	Low	Low	Low	Low	Low	Low
Amelia	Low	Low	Low	Low	Low	Low	Low	Low
Amherst	Low	Medium	Low	Low	Low	Low	Low	Low
Appomattox	Low	Low	Low	Low	Low	Low	Low	Low
Arlington	Low	High	Low	Low	Low	Low	Low	Low
Augusta	Low	Medium	Low	Low	Low	Low	Low	Low
Bath	Low	Low	Low	Low	Low	Low	Low	Low
Bedford	Low	Medium	Low	Low	Low	Low	Low	Low
Bland	Low	Low	Low	Low	Low	Low	Low	Low
Botetourt	Low	Medium	Low	Low	Low	Low	Low	Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Brunswick	Low	Low	Low	Low	Low	Low	Low	Low
Buchanan	Low	Low	Low	Low	Low	Low	Low	Low
Buckingham	Low	Low	Low	Low	Low	Low	Low	Low
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Campbell	Low	Medium	Low	Low	Low	Low	Low	Low
Caroline	Low	Low	Low	Low	Low	Low	Low	Low
Carroll	Low	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Charles City	Low	Low	Low	Low	Low	Low	Low	Low
Charlotte	Low	Low	Low	Low	Low	Low	Low	Low
Charlottesville, City of	Low	High	Low	Low	Low	Low	Low	Low
Chesapeake, City of	High	Medium-High	Low	Low	Low	Low	Medium	Medium-Low
Chesterfield	Low	Medium-High	Low	Low	Low	Low	Low	Low
Clarke	Low	Medium	Low	Low	Low	Low	Low	Low
Colonial Heights, City of	Low	High	Low	Low	Low	Low	Low	Low
Covington, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Craig	Low	Low	Low	Low	Low	Low	Low	Low
Culpeper	Low	Medium	Low	Low	Low	Low	Low	Low
Cumberland	Low	Low	Low	Low	Low	Low	Low	Low
Danville, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Dickenson	Low	Low	Low	Low	Low	Low	Low	Low
Dinwiddie	Low	Low	Low	Low	Low	Low	Low	Low
Emporia	Low	Medium-High	Low	Low	Low	Low	Low	Low
Essex	Low	Low	Low	Low	Low	Low	Low	Low
Fairfax	Low	High	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Fairfax, City of	Low	High	Low	Low	Low	Low	Low	Low
Falls Church, City of	Low	High	Low	Low	Low	Low	Low	Low
Fauquier	Low	Medium	Low	Low	Low	Low	Low	Low
Floyd	Low	Low	Low	Low	Low	Low	Low	Low
Fluvanna	Low	Medium	Low	Low	Low	Low	Low	Low
Franklin	Medium	Medium	Low	Low	Low	Low	Medium	Medium-Low
Franklin, City of	Low	Medium-High	Low	Low	Low	Low	Medium	Low
Frederick	Low	Medium	Low	Low	Low	Low	Low	Low
Fredericksburg, City of	Low	High	Low	Low	Low	Low	Low	Low
Galax, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Giles	Low	Low	Low	Low	Low	Low	Low	Low
Gloucester	Medium	Medium	Low	Low	Low	Low	Medium	Medium-Low
Goochland	Low	Medium	Low	Low	Low	Low	Low	Low
Grayson	Low	Low	Low	Low	Low	Low	Low	Low
Greene	Low	Medium	Low	Low	Low	Low	Low	Low
Greensville	Low	Low	Low	Low	Low	Low	Low	Low
Halifax	Low	Low	Low	Low	Low	Low	Low	Low
Hampton, City of	Medium-High	High	Low	Low	Low	Low	Medium	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Hanover	Low	Medium	Low	Low	Low	Low	Low	Low
Harrisonburg, City of	Low	High	Low	Low	Low	Low	Low	Low
Henrico	Low	Medium-High	Low	Low	Low	Low	Low	Low
Henry	Low	Medium	Low	Low	Low	Low	Low	Low
Highland	Low	Low	Low	Low	Low	Low	Low	Low
Hopewell, City of	Low	High	Low	Low	Low	Low	Low	Low
Isle of Wight	Medium	Medium	Low	Low	Low	Low	Medium	Medium-Low
James City	Medium-High	Medium-High	Low	Low	Low	Low	Medium	Medium-Low
King and Queen	Low	Low	Low	Low	Low	Low	Low	Low
King George	Low	Medium	Low	Low	Low	Low	Low	Low
King William	Low	Low	Low	Low	Low	Low	Low	Low
Lancaster	Low	Medium	Low	Low	Low	Low	Low	Low
Lee	Low	Low	Low	Low	Low	Low	Low	Low
Lexington, City of	Low	High	Low	Low	Low	Low	Low	Low
Loudoun	Low	Medium-High	Low	Low	Low	Low	Low	Low
Louisa	Low	Medium	Low	Low	Low	Low	Low	Low
Lunenburg	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Madison	Low	Low	Low	Low	Low	Low	Low	Low
Manassas, City of	Low	High	Low	Low	Low	Low	Low	Low
Manassas Park, City of	Low	High	Low	Low	Low	Low	Low	Low
Martinsville, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Mathews	Low	Medium	Low	Low	Low	Low	Low	Low
Mecklenburg	Low	Low	Low	Low	Low	Low	Low	Low
Middlesex	Low	Medium	Low	Low	Low	Low	Low	Low
Montgomery	Low	Medium	Low	Low	Low	Low	Low	Low
Nelson	Low	Low	Low	Low	Low	Low	Low	Low
New Kent	Low	Medium	Low	Low	Low	Low	Low	Low
Newport News, City of	High	High	Low	Low	Low	Low	Medium	Medium-Low
Norfolk, City of	High	High	Low	Low	Low	Low	Medium	Medium-Low
Northampton	Low	Medium	Low	Low	Low	Low	Low	Low
Northumberland	Low	Low	Low	Low	Low	Low	Low	Low
Norton	Low	Medium-High	Low	Low	Low	Low	Low	Low
Nottoway	Low	Low	Low	Low	Low	Low	Low	Low
Orange	Low	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Page	Low	Medium	Low	Low	Low	Low	Low	Low
Patrick	Low	Low	Low	Low	Low	Low	Low	Low
Petersburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Pittsylvania	Low	Medium	Low	Low	Low	Low	Low	Low
Poquoson	Low	Medium-High	Low	Low	Low	Low	Medium	Medium-Low
Portsmouth, City of	Medium-High	High	Low	Low	Low	Low	Medium	Medium-Low
Powhatan	Low	Medium	Low	Low	Low	Low	Low	Low
Prince Edward	Low	Medium	Low	Low	Low	Low	Low	Low
Prince George	Low	Medium	Low	Low	Low	Low	Low	Low
Prince William	Low	Medium-High	Low	Low	Low	Low	Low	Low
Pulaski	Low	Medium	Low	Low	Low	Low	Low	Low
Radford, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Rappahannock	Low	Low	Low	Low	Low	Low	Low	Low
Richmond	Low	Low	Low	Low	Low	Low	Low	Low
Richmond, City of	Low	High	Low	Low	Low	Low	Low	Low
Roanoke	Low	Medium-High	Low	Low	Low	Low	Low	Low
Roanoke, City of	Low	High	Low	Low	Low	Low	Low	Low
Rockbridge	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Rockingham	Low	Medium	Low	Low	Low	Low	Low	Low
Russell	Low	Low	Low	Low	Low	Low	Low	Low
Salem, City of	Low	High	Low	Low	Low	Low	Low	Low
Scott	Low	Low	Low	Low	Low	Low	Low	Low
Shenandoah	Low	Medium	Low	Low	Low	Low	Low	Low
Smyth	Low	Medium	Low	Low	Low	Low	Low	Low
Southampton	Low	Low	Low	Low	Low	Low	Medium	Low
Spotsylvania	Low	Medium	Low	Low	Low	Low	Low	Low
Stafford	Low	Medium-High	Low	Low	Low	Low	Low	Low
Staunton, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Suffolk	Medium-High	Medium	Low	Low	Low	Low	Medium	Low
Surry	Low	Low	Low	Low	Low	Low	Medium	Low
Sussex	Low	Low	Low	Low	Low	Low	Low	Low
Tazewell	Low	Medium	Low	Low	Low	Low	Low	Low
Virginia Beach, City of	High	High	Low	Low	Low	Low	Medium	Medium-Low
Warren	Low	Medium	Low	Low	Low	Low	Low	Low
Washington	Low	Medium	Low	Low	Low	Low	Low	Low
Waynesboro, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Westmoreland	Low	Medium	Low	Low	Low	Low	Low	Low
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Winchester, City of	Low	High	Low	Low	Low	Low	Low	Low
Wise	Low	Medium	Low	Low	Low	Low	Low	Low
Wythe	Low	Medium	Low	Low	Low	Low	Low	Low
York	Medium-High	Medium-High	Low	Low	Low	Low	Medium	Medium-Low

For the 2018 plan, the overall hazard ranking for land subsidence is low.

Table 3.14-4: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts are expected to be moderate to severe in the impact area.
Health and Safety of Response Personnel	Limited unless involves broken utility lines.
Continuity of Operations	Limited, unless a facility is impacted
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure in the area of the event could be severe.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be moderate for the impacted areas. Always a potential for utility line breaks.
Economic and Financial Condition	Limited. Depending on the magnitude of the event, local economy and finances may be impacted.
Public Confidence in the Jurisdiction's Governance	Localized impacts expected to cause property owners confidence in state and local land use/development policies to waiver.

Endnotes

[1] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[2] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[3] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[4] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[5] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[6] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[7] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[8] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[9] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
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[11] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf

[12] US Geological Survey. *Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region.* Retrieved 05.01.17 from https://pubs.usgs.gov/circ/1392/pdf/circ1392.pdf
[13] Virginia Institute of Marine Science. *Chesapeake Bay Land Subsidence and Sea Level Change: An Evaluation of Past and Present Trends and Future Outlook.* Retrieved 05.01.17 from http://www.vims.edu/GreyLit/VIMS/sramsoe425.pdf

Section 3.15: Non-Rotational Winds

Description



Hurricane Isabel, City of Richmond 2003
Source: Bill Hark, www.harkphoto.com/isabel.html

Tropical cyclones involve both atmospheric and hydrologic characteristics, such as severe winds, storm surge flooding, high waves, coastal erosion, extreme rainfall, thunderstorms, lightning, and, in some cases, tornadoes. Storm surge flooding can push inland, and riverine flooding associated with heavy inland rains can be extensive. Many areas of the Tidewater region are flat, and intense prolonged rainfall tends to accumulate without ready drainage paths. Of concern with extreme rainfall is the Chowan River Basin, which has relatively no elevation and results in flood events like back-to-back Hurricanes Dennis and Floyd, which devastated the City of Franklin and other communities along the Blackwater River. Extreme rainfall in the higher elevations can also result in secondary hazards, such as landslides and debris flows as witnessed during Hurricane Camille in Nelson County. High winds are also associated with hurricanes, with two significant effects: widespread debris due to damaged and downed trees and building debris; and power outages. The Tidewater region, including areas on tidal-influenced tributaries, is vulnerable to hurricanes and their effects.

As a storm moves into more shallow waters, the waves lessen, but water levels rise, bulging up on the storm's right-front quadrant (RFQ) in what is called the storm surge, as shown in Figure 3.15-1. This is the deadliest part of a hurricane, as it contains the strongest winds. The storm surge and wind driven waves can devastate a coastline and bring ocean water several miles inland. Once inland, the hurricane's band of thunderstorms produces torrential rains and sometimes tornadoes. A foot or more of rain may fall in less than a day causing flash floods and mudslides. The rain eventually drains into the large rivers, which may still be flooding days after the storm has passed. The storm's driving winds can topple trees, utility poles, and damage buildings. Communication and electricity is lost for days and roads are impassable due to fallen trees and debris.

Figure 3.15-1: Right-Front Quadrant (RFQ) of a hurricane is the stronger side of the storm and creates the highest storm surge



The hurricanes that affect Virginia typically form in the Atlantic or Gulf of Mexico during the months of June through November. These storms form from strong low-pressure systems originating in the tropics, which cause the updraft of warm ocean water. Typically, these systems result in strong damaging winds and high seas that can cause flooding. A storm originating in the Atlantic is defined as a hurricane when the maximum sustained winds reach 74 miles per hour. Below this level, it is defined as either a tropical storm or tropical depression.

The Saffir-Simpson Hurricane Scale is a 1-5 rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline in the landfall region. Note that all winds are using the US 1-minute average[1].

Hurricanes are categorized by the Safer-Simpson Hurricane Damage Scale. Table 3.15-1 provides a detailed description of each hurricane category, potential damage caused, and the name and strength of hurricanes as they passed near or through Virginia.

Table 3.151: Saffir-Simpson Hurricane Damage Scale. From National Weather Service National Hurricane Center and Virginia's Warning Coordination Meteorologist. Historical events from FEMA and VDEM

Category	**Wind Speeds** (US 1-min average.)	**Damage Potential**	**Damage Description pertaining to the effects of wind only** Heavy rains can occur at any level	**Historical Hurricane Category in Virginia** (* indicates a Federal Disaster Declaration)
Tropical Depression Tropical Storm	<38 mph (TD) <33 kt <62 kh/hr 39-73 mph (TS) 34-63 kt 63 – 118 km/hr	Negligible	Wind effects: Scattered trees down, scattered power outages, some roads blocked due to downed trees and power lines. For example, neighborhoods could lose power for several days. *This damage description is more likely associated with a tropical storm than a tropical depression.*	Hurricane Diane (8/17/1955) Hurricane Camille (8/20/1969) Tropical Storm Doria (8/27/1971) Tropical Storm Agnes (6/21/1972)* Hurricane Hugo (9/9/1989) Hurricane Bertha (7/12-13/1996) Hurricane Fran (9/5-6/1996)* Hurricane Danny (7/24/1997) Hurricane Dennis (9/4-5/1999)* Hurricane Floyd (9/15-16/1999)* Hurricane Isabel (9/18/2003)* Hurricane Charley (8/14/2004) Hurricane Gaston (8/29/2004) Hurricane Frances (9/8/2004) Hurricane Ivan (9/17/2004) Hurricane Jeanne (9/28/2004) Tropical Storm Ernesto (9/1/2006)* Tropical Storm Lee (9/8-9/2011)* Hurricane Matthew (10/9/2016)*

Category	Wind Speeds (US 1-min average.)	Damage Potential	Damage Description pertaining to the effects of wind only Heavy rains can occur at any level	Historical Hurricane Category in Virginia (* indicates a Federal Disaster Declaration)
1	74 – 95 mph 64-82 kt 119-153 km/hr	Minimal	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, and vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.	Chesapeake-Potomac Hurricane of 1933 Hurricane Hazel (10/15/1954) Hurricane Charley (9/17/1986 Hurricane Bonnie (8/27/1998)* Hurricane Irene (8/27/2011)*
2	96 – 110 83-95 kt 154-177 km/hr	Moderate	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.	The Great Hurricane (9/14/1944) Hurricane Donna (9/12/1960) Hurricane Gloria (9/27/1985) Hurricane Sandy (10/26-11/8/2012)*
3 (major)	111 – 129 mph 96 - 112 kt 178 - 208 km/hr	Extensive	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.	
4 (major)	130 – 156 mph 113-136 kt 209-251 km/hr	Extreme	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.	

Category	**Wind Speeds** (US 1-min average.)	**Damage Potential**	**Damage Description pertaining to the effects of wind only** Heavy rains can occur at any level	**Historical Hurricane Category in Virginia** (* indicates a Federal Disaster Declaration)
5 (major)	> 157 mph > 137 kt >252 km/hr	Catastrophic	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.	*Meteorologists consider the water off the Virginia coast too cool to support a Category 5 storm.*

Other non-rotational wind events include severe thunderstorms, wind storms, and derechos. A derecho is a widespread straight-line windstorm linked to a band of severe thunderstorms. Derechos are mainly a warm-weather phenomenon, occurring mostly in June and July in the Northern Hemisphere. Derechos are a thunderstorm complex, producing a band of winds at least 240 miles in length with wind speeds of at least 58 mph or greater along most of its length[2]. Derechos can produce damage comparable to tornados.

Historic Occurrence

As expected, most hurricanes affect eastern Virginia due to its proximity to the coast. However, it is not uncommon for hurricanes and tropical storms to track through the state and impact non-coastal jurisdictions. NCEI includes information on hurricane events and their effects. The events included in Table 3.15-2 summarize some of the major non-rotational wind events that have historically affected Virginia. Federally declared hurricane and other non-rotational wind related events are listed in Section 3.3. Figure 3.15-2 shows the paths of historical hurricanes that have passed through Virginia. Figures 3.15-3 through 3.15-9 show the paths of historical hurricanes by VDEM region.

Figure 3.15-10 shows Hurricane Hazel and Figure 3.15-11 shows Hurricane Camille. These are included to provide examples of historical hurricane events that affected Virginia. These figures identify the main path of the storms and the peak windspeeds that jurisdictions may have experienced at that time. HAZUS-MH was used to simulate these historical occurrences. These figures were originally created for the 2013 version of this plan, but – given their historic content – remain valid and therefore included in this update.

Virginia has experienced several lulls in hurricane activity since reliable records began. One possibility for these peaceful periods is the phenomenon called El Nino. El Nino causes stronger westerly winds in the atmosphere over the southeastern US. These winds tend to shear hurricanes apart and help steer them away from the mainland. La Nina, the opposite of El Nino, brings cold waters over the equatorial Pacific, and there tends to be a dramatic increase in hurricane activity. Between 1951 and 1960, Virginia was affected by 16 storms, including Hazel, Connie, Diane and Flossy.[3]

Table 3.15-2: Historical Hurricanes and other Non-Rotational Wind Events (1749-2016)

Year	System Name	Description
1749	None	A tremendous hurricane created Willoughby Spit, south of Hampton. The Bay rose 15 feet above normal. In Williamsburg, a family drowned as floodwaters carried their house away. At Hampton, water rose to four feet deep in the streets; many trees were uprooted or snapped in two. Bodies washed ashore from shipwrecks for days afterward.

Year	System Name	Description
1769	None	A strong hurricane struck near Williamsburg causing "inconceivable" damages to homes and crops. Many ships on the Chesapeake were damaged by storm winds and waves.
1806	Great Hurricane of 1806	A slow moving storm completed the creation of Willoughby Spit, damaged warships, and damaged a seawall.
1878	Gale of '78	A strong hurricane moved quickly from the Bahamas up the North Carolina Coast through the eastern portion of the state, completely submerging Cobb and Smith Islands in the Chesapeake Bay. (Middle Peninsula).
1933	Chesapeake-Potomac Storm of '33	Record high tides in many locations; approximately 9.8 feet above mean lower low water. There were four casualties on the Peninsula: two in Hampton, one in James City County, and one in York County. At Buckroe Beach in Hampton, and at Yorktown, martial law was declared and National Guard troops were brought in to prevent looting. Flooding was severe in low-lying parts of Hampton (Fox Hill and Buckroe), York County (Goodwin Neck), and Newport News (Small Boat Basin). Jamestown Island was severely damaged.
1954	Hurricane Hazel	Hurricane Hazel inflicted 130 mph winds on Hampton and blew apart at least one anemometer there. There was one casualty on the Peninsula in the Dare section of York County.
1955	Hurricanes Connie & Diane	Five days after Hurricane Connie, Diane made landfall in North Carolina as a Category 1 and moved North across Central Virginia. Five to ten inches of rain fell along the Blue Ridge Mountains. Hurricane Connie and Diane are attributed to the record rainfall in August of that year. Statewide damages totaled $1.5 million.
1957	Nor'Easter	A Nor'easter brought extremely high tides to the Town of Wachapreague on the Eastern Shore up to four feet above normal. (Eastern Shore PDC)
1969	Hurricane Camille	Hurricane Camille described earlier in the discussion on federal disaster declarations (section 3.3) and in flooding (section 3.10).
1972	Tropical Storm Agnes	Tropical Storm Agnes is described earlier in the discussion on federal disaster declarations (section 3.3) and in flooding (section 3.10).
1996	Hurricane Fran	Hurricane Fran described earlier in the discussion on federal disaster declarations (section 3.3).
1998	Nor'easter	Much of the eastern portion of the state was affected by a slow moving Nor'easter. This storm caused severe coastal flooding in the Hampton Roads area and on the Eastern Shore. The causeway to Chincoteague Island was closed and the entire island was submerged under floodwaters. Several streets in Norfolk were closed due to over three feet of water, and at least one family in Gloucester County was rescued by rowboat. There were no reported injuries or fatalities, but damages were estimated at $75 million. (Eastern Shore HMP)
1999	Hurricane Floyd	Hurricane Floyd described earlier in the discussion on federal disaster declarations (section 3.3).
2003	Hurricane Isabel	Hurricane Isabel described earlier in the discussion on federal disaster declarations (section 3.3).
2004	Tropical Depression Gaston	Tropical Depression Gaston described earlier in the discussion on federal disaster declarations (section 3.3).

Year	System Name	Description
2006	Nor'easter	A Nor'easter impacted the southeastern portion of the state causing minor flooding in the City of Chesapeake and the City of Hampton. The City of Franklin along the Blackwater River experienced their 2nd flood of record at 22.77 feet. This happened only 7 years after the city experienced their flood of record during Hurricane Floyd, which crested at 26.27 feet (flood stage is 12 feet).
2006	Tropical Storm Ernesto	Tropical Storm Ernesto described in the discussion of federal disaster declarations (section 3.3).
2009	Nor'easter and Remnants of Tropical Depression Ida	Nor'easter and remnants of Tropical Depression Ida described in the discussion of federal disaster declarations (section 3.3).
2011	Hurricane Irene	Hurricane Irene described in the discussion of federal disaster declarations (section 3.3).
2011	Remnants of Tropical Storm Lee	Tropical Storm Lee described in the discussion of federal disaster declarations (section 3.3).
2012	Derecho	Derecho described in the discussion of federal disaster declarations (section 3.3).
2012	Hurricane Sandy	Hurricane Sandy described in the discussion of federal disaster declarations (section 3.3).
2016	Hurricane Matthew	Hurricane Matthew described in the discussion of the federal disaster declarations (section 3.3).

Figure 3.15-2: Virginia Hurricane History (1851-2016)

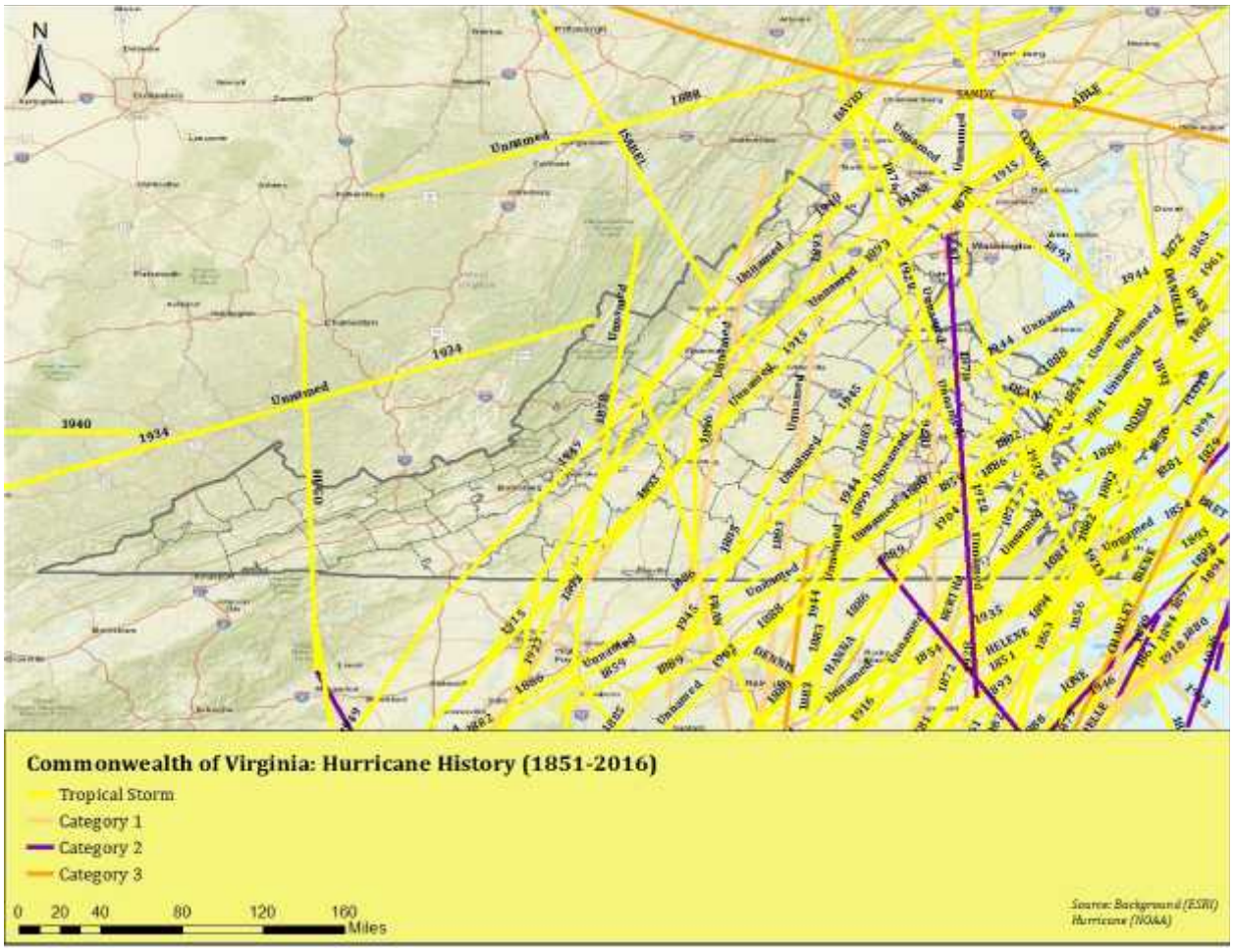


Figure 3.15-3: Hurricane History - VDEM Region 1

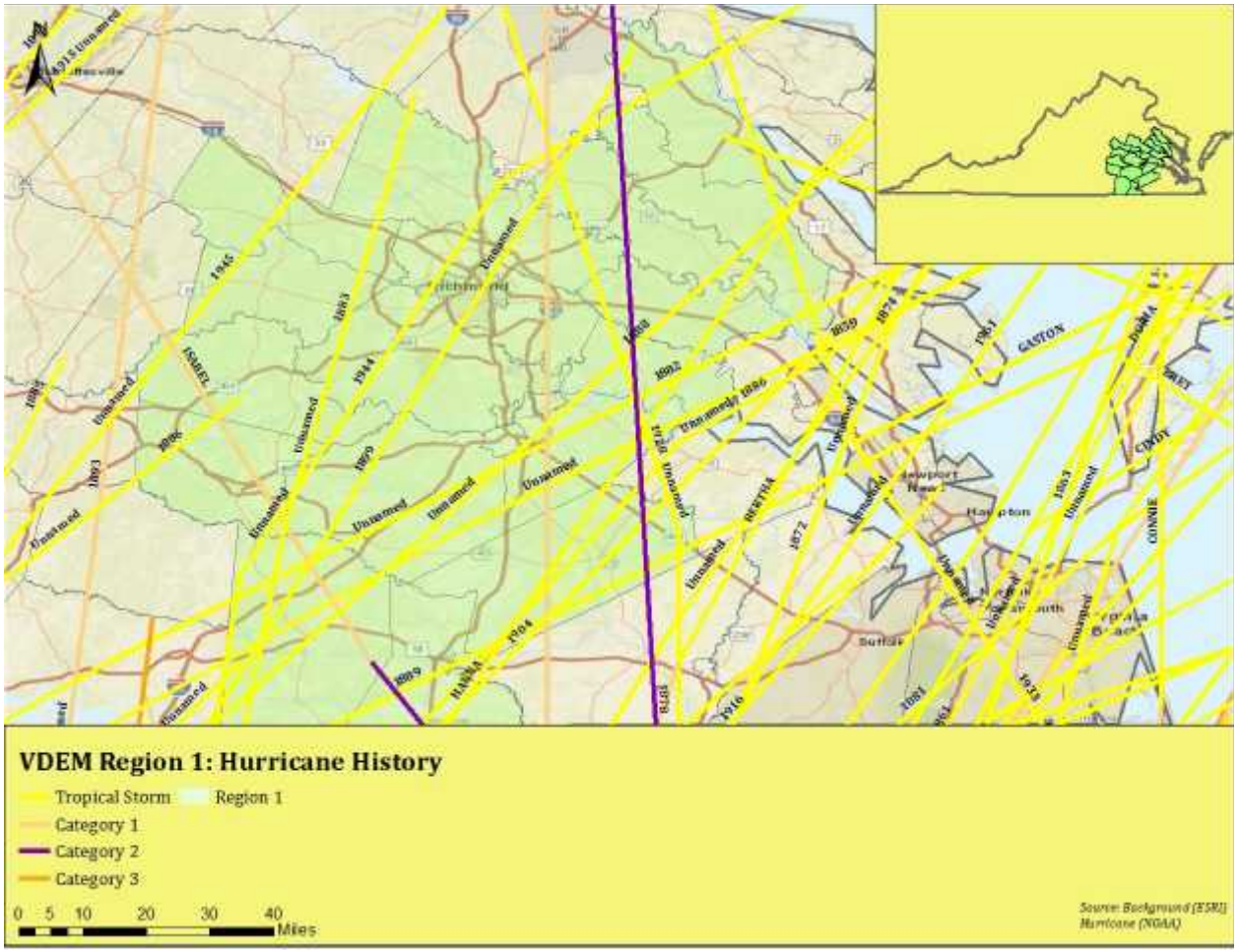


Figure 3.15-4: Hurricane History - VDEM Region 2

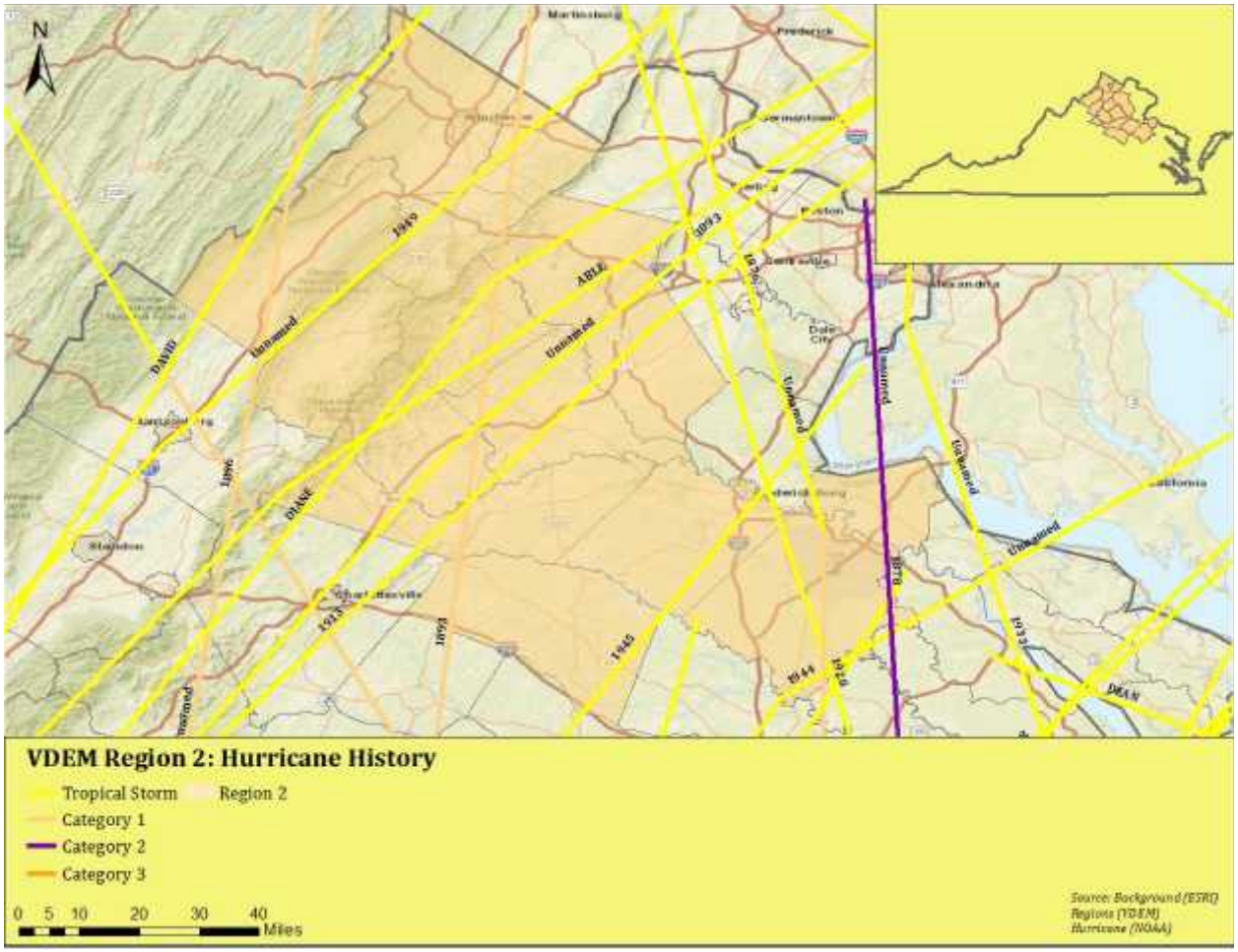


Figure 3.15-5: Hurricane History - VDEM Region 3

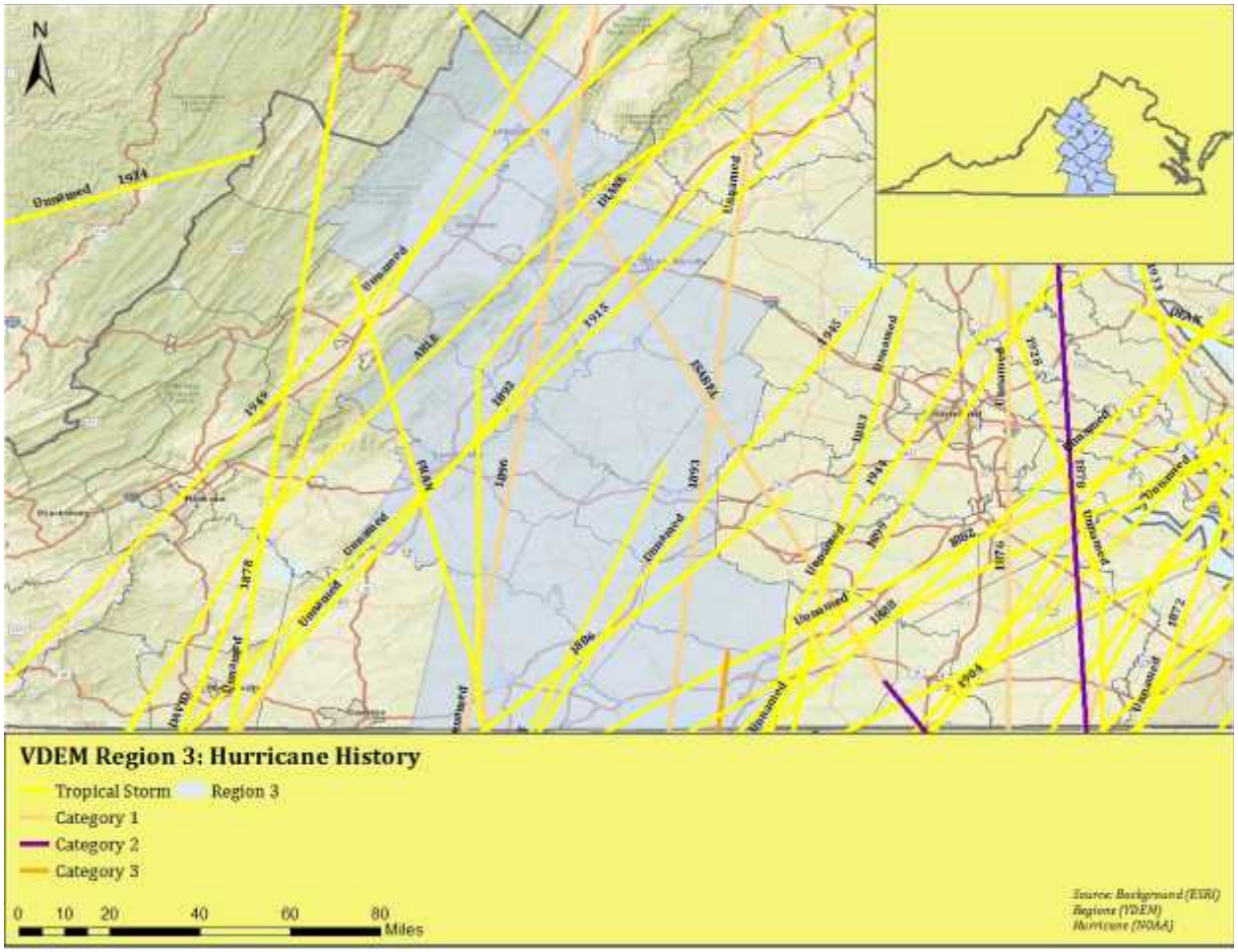


Figure 3.15-6: Hurricane History - VDEM Region 4

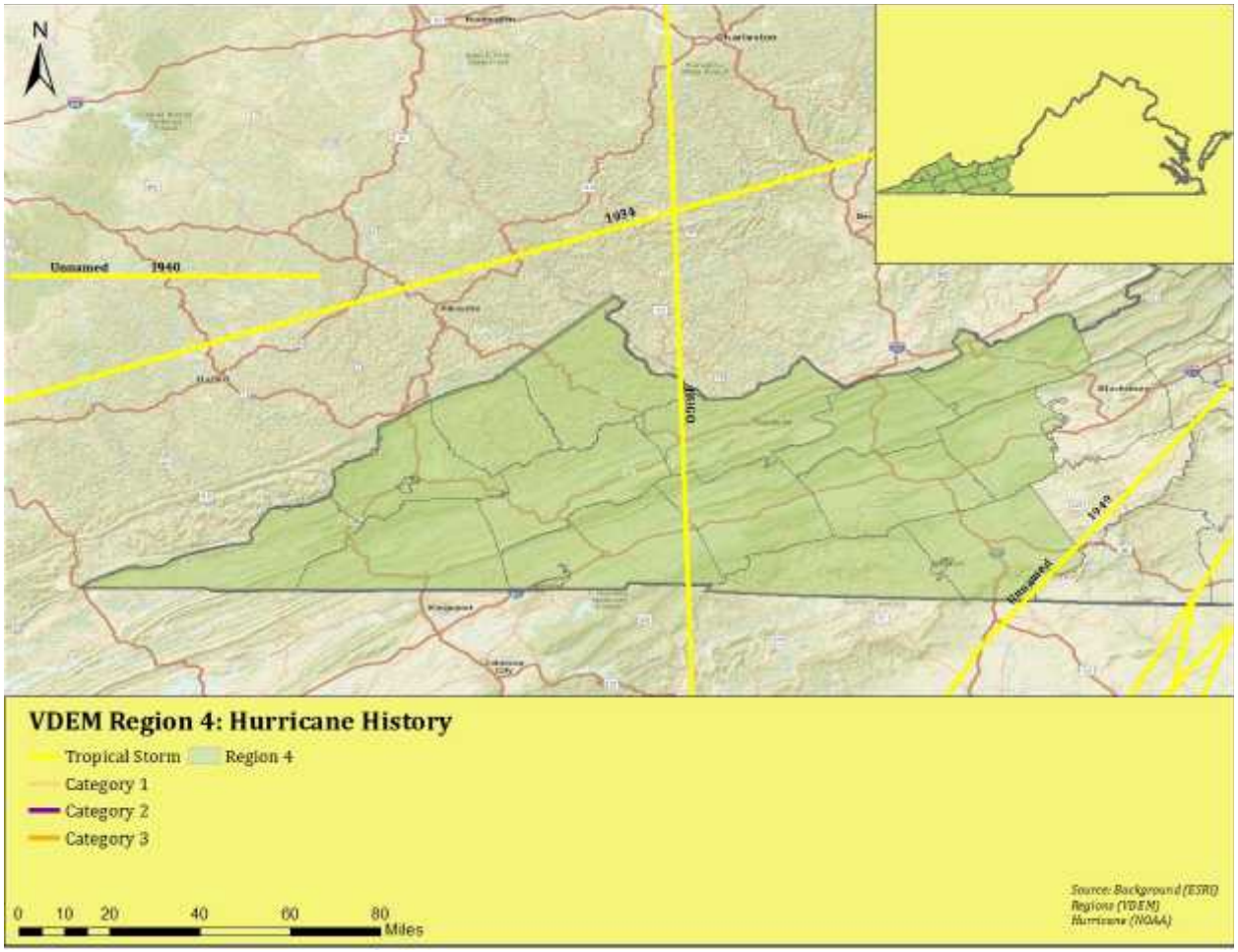


Figure 3.15-7: Hurricane History - VDEM Region 5

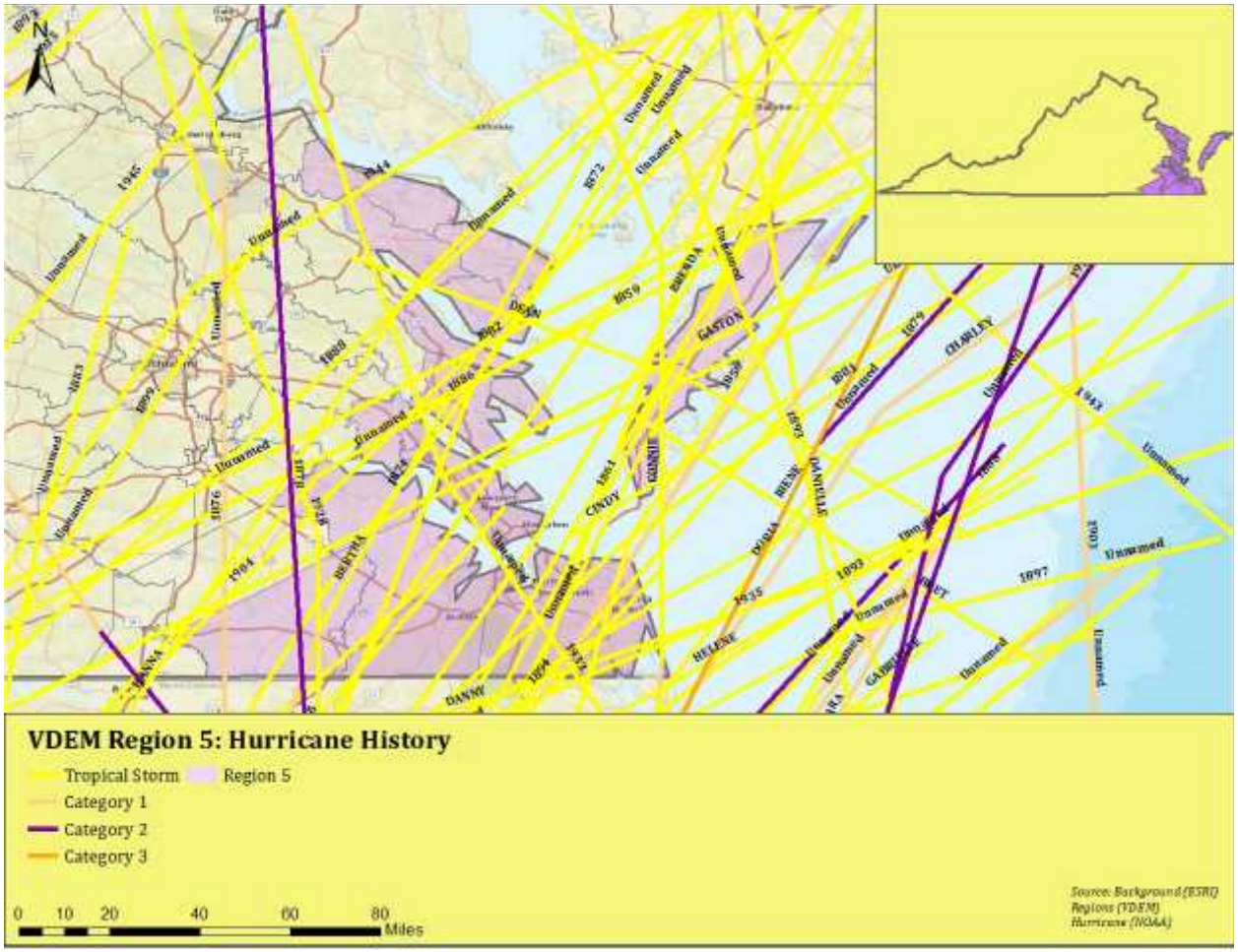


Figure 3.15-8: Hurricane History - VDEM Region 6

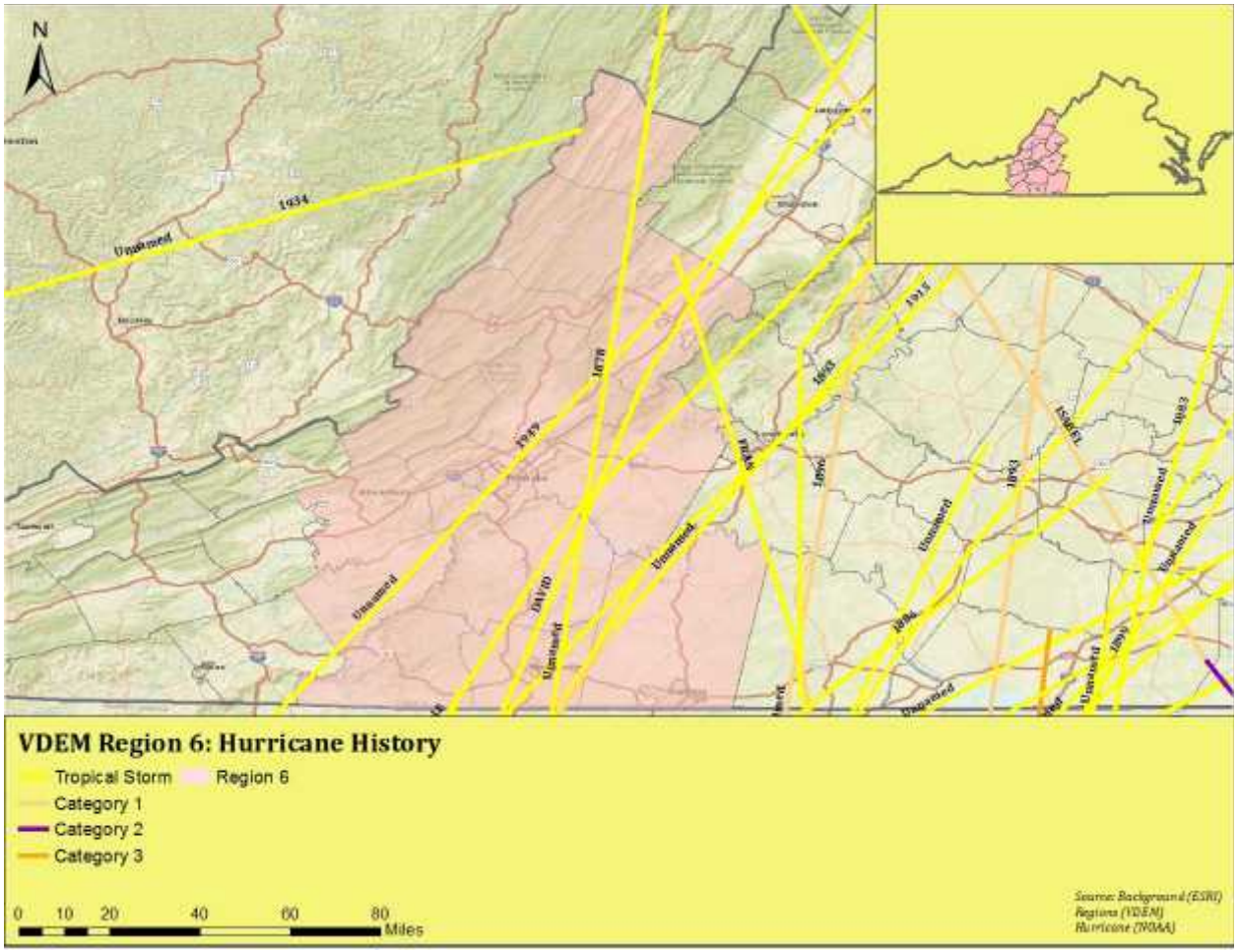


Figure 3.15-9: Hurricane History - VDEM Region 7

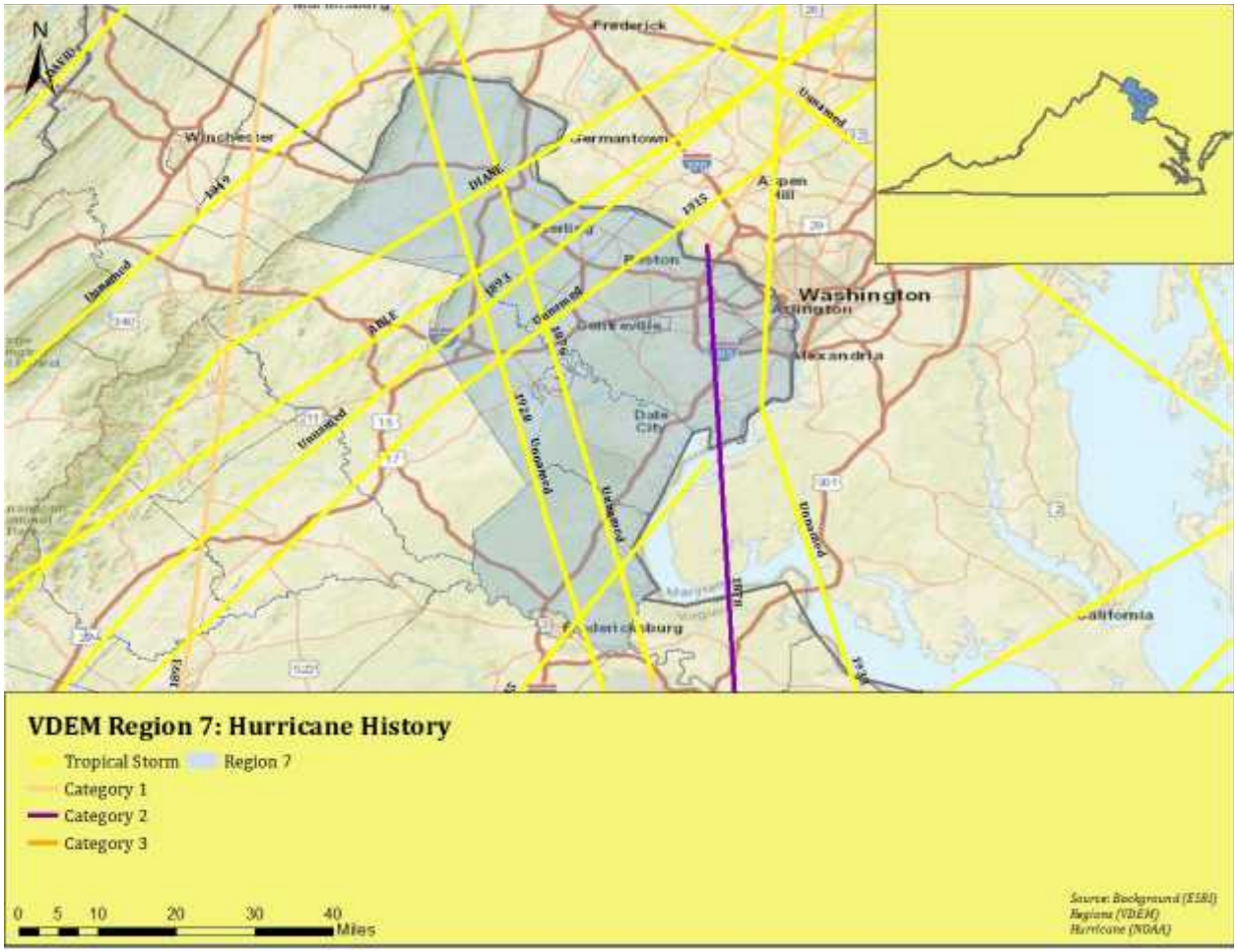


Figure 3.15-10: Historical Occurrence: 1954 - Hurricane Hazel

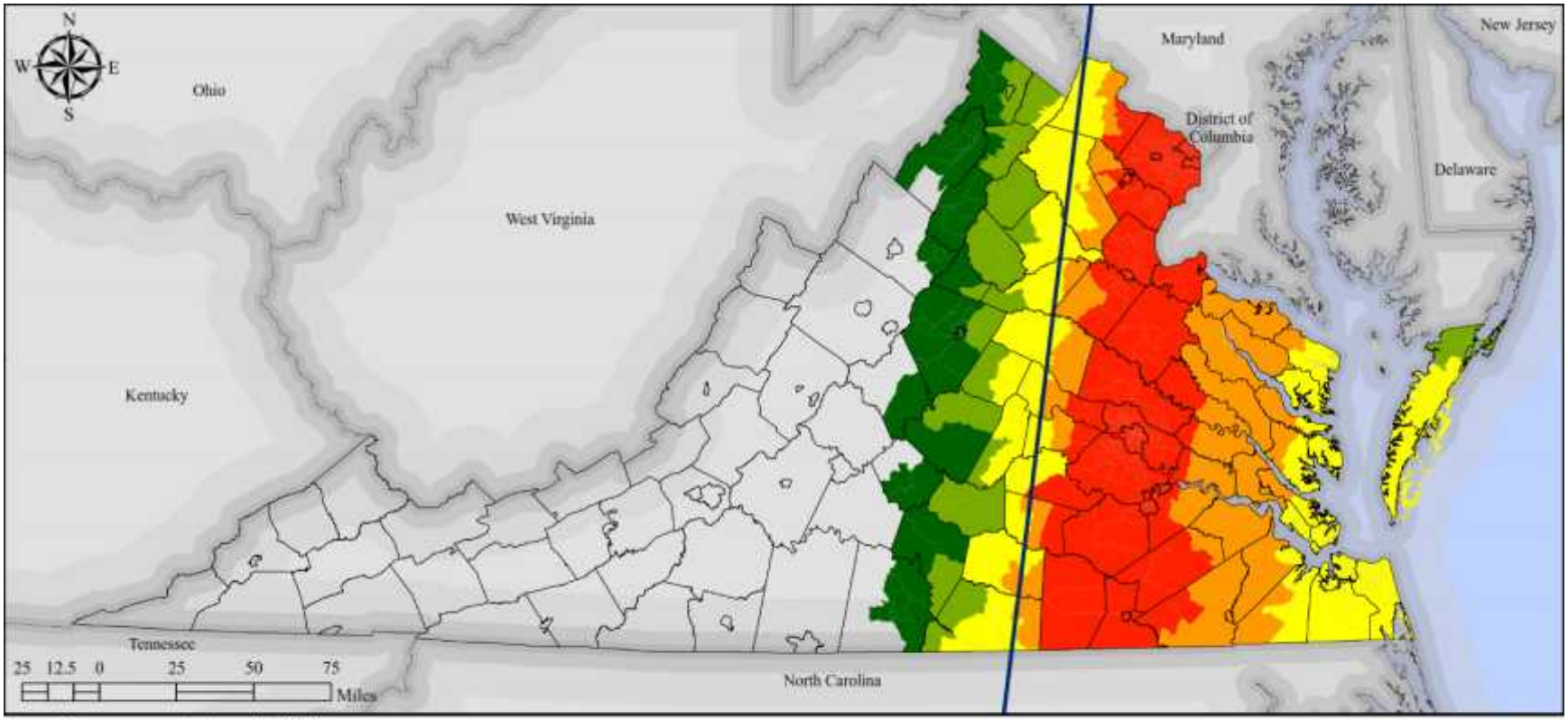
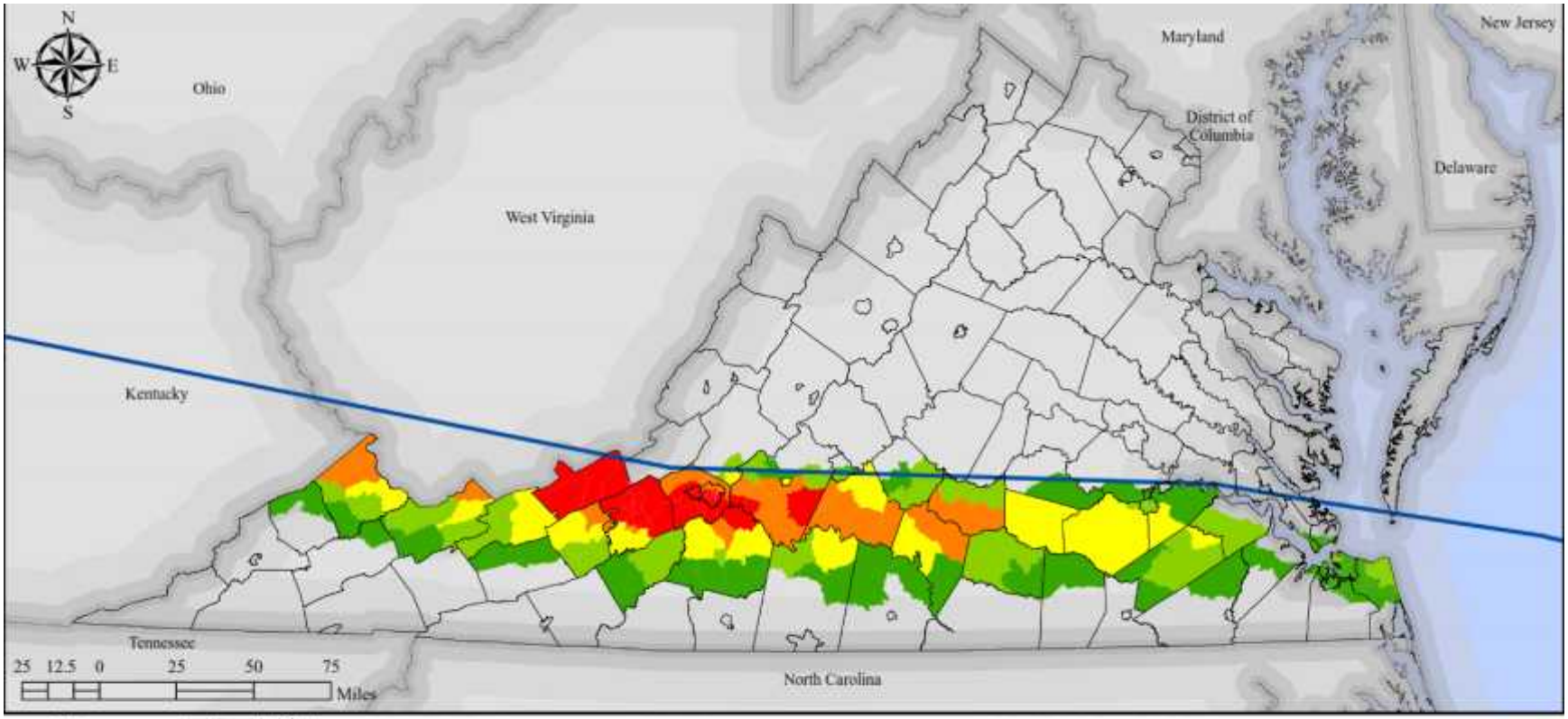


Figure 3.15-11: Historical Occurrence: 1969 - Hurricane Camille



Risk Assessment

FEMA's HAZUS-MH v3.2 hurricane model was used to estimate annualized losses for the Commonwealth. HAZUS-MH allows users to estimate hurricane winds and potential damage and loss to residential, commercial, and industrial buildings. The model makes use of state-of-the-art wind field models, calibrated and validated using full-scale hurricane data. Wind speed has been calculated as a function of central pressure, translation speed, and surface roughness. This revision of the plan utilizes a Level 1 analysis for the hurricane wind module. Level 1 analysis involves using the provided hazard and inventory data with no outside data collection. This is an acceptable level of information for state hazard mitigation planning. Future revisions to this plan may enhance the analysis to Level 2 or 3, based on data available at that time.

Probability

Most office buildings are designed for a 50-year mean recurrence interval wind event (two percent annual probability. The American Society of Civil Engineers (ASCE) publication 7-10, *Minimum Design Loads for Buildings and Other Structures*, requires office buildings where more than 300 people congregate in one area to be designed for a 100-year mean recurrence interval wind event; therefore, these office buildings are designed to resist stronger, rarer storms than most office buildings[4]. Other office buildings that must be designed for a 100-year mean recurrence interval wind event include:

1. Buildings that will be used for hurricane or other emergency shelter;
2. Buildings housing a day care center with capacity greater than 150 occupants;
3. Buildings designated for emergency preparedness, communication, or emergency operation center or response;
4. Buildings housing critical national defense functions; and
5. Buildings containing sufficient quantities of hazardous materials.

HAZUS-MH was used to determine the 100-year probabilistic return period for each VDEM region. Geographic extent has been based off these values for determining risk and ranking. This represents the wind peak gusts that have a one percent annual probability of occurrence. The one percent annual probability wind speeds is the estimated 3-second gusts in open terrain at ten meters above ground at the center of each census tract. Figures 3.15-13 through 19 illustrate the 100-year probabilistic return period wind speeds for each VDEM region.

Figure 3.15-13: HAZUS-MH - 100-Year Wind Speeds – VDEM Region 1

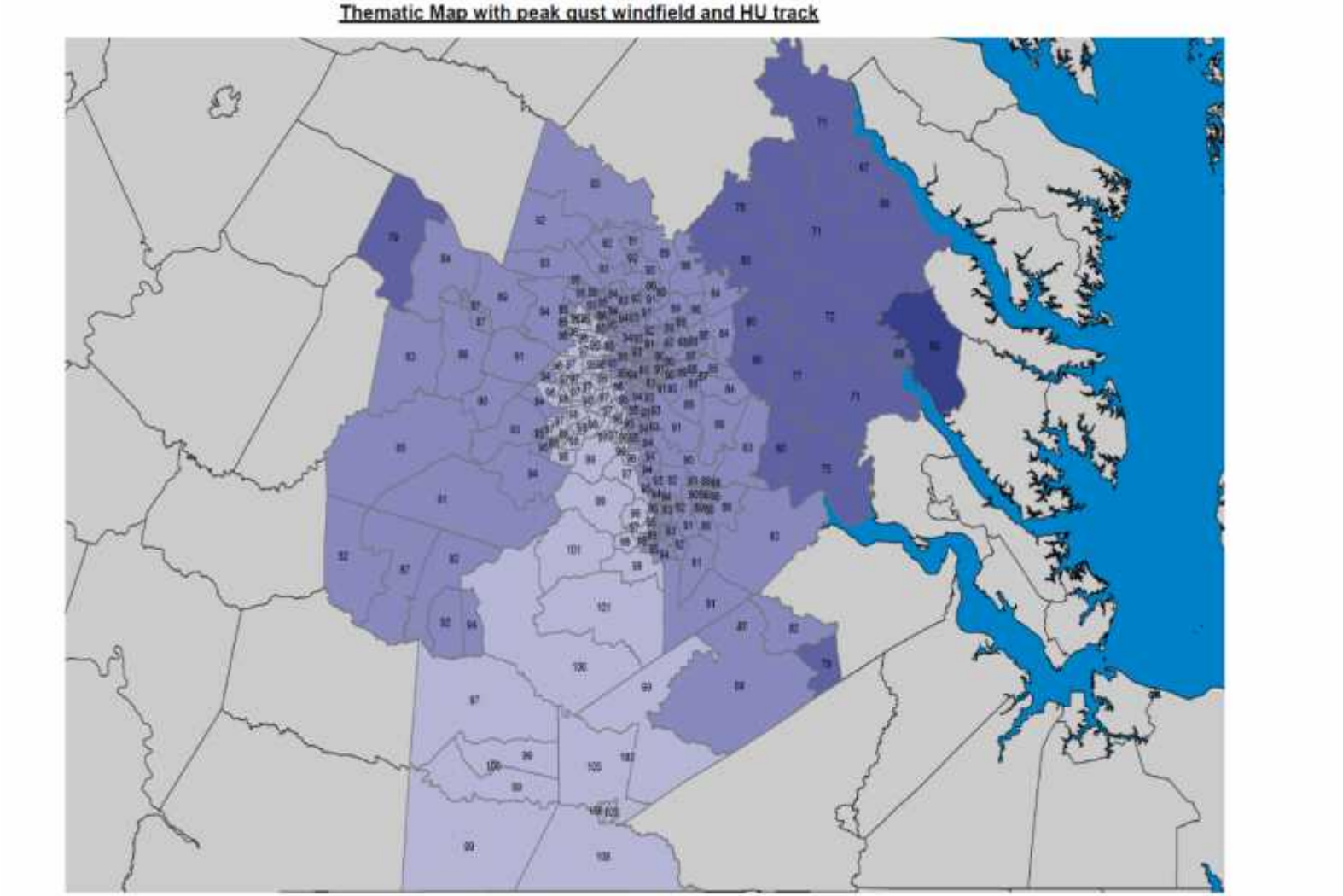


Figure 3.15-14: HAZUS-MH - 100-Year Wind Speeds – VDEM Region 2

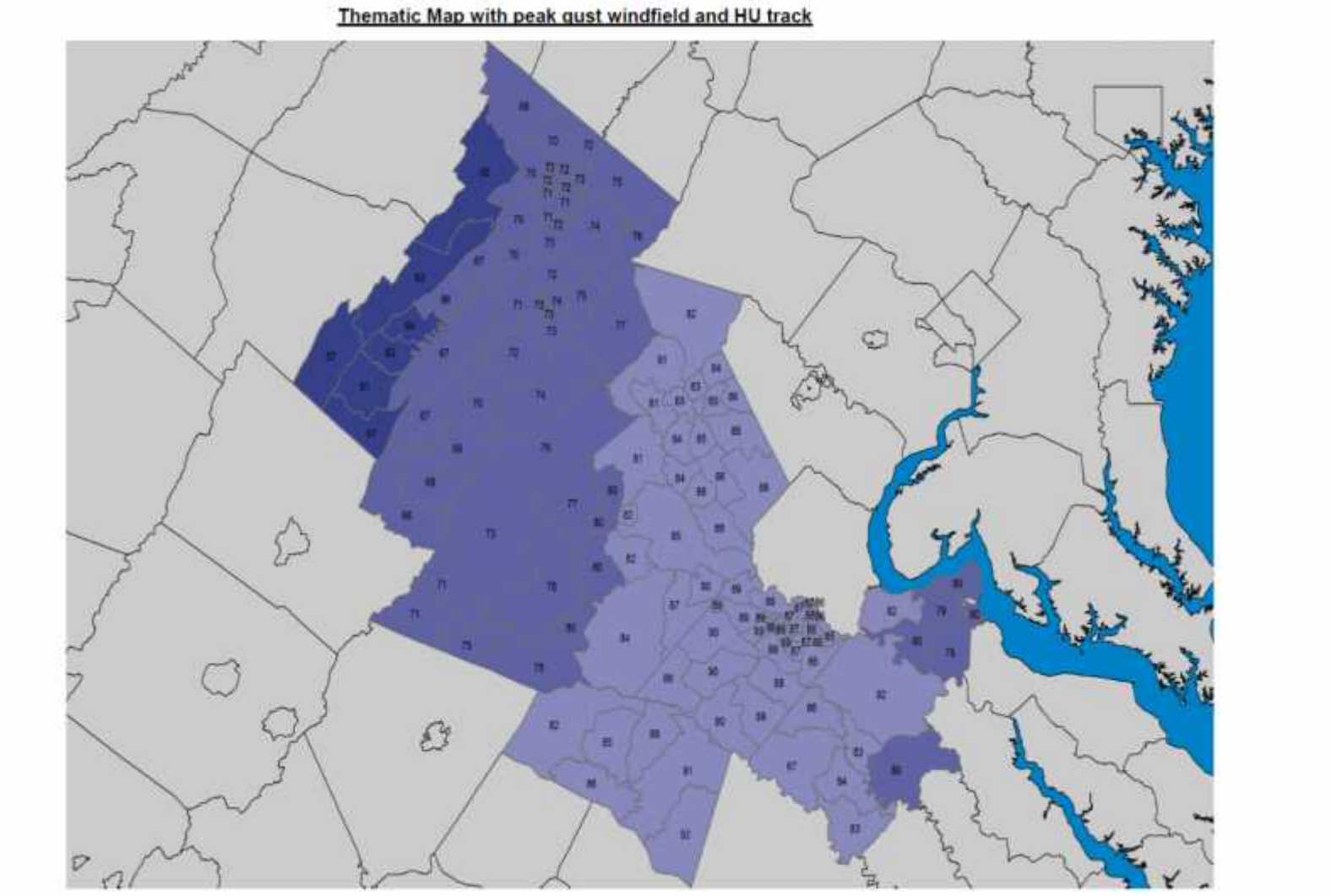


Figure 3.15-15: HAZUS-MH - 100-Year Wind Speeds – VDEM Region 3

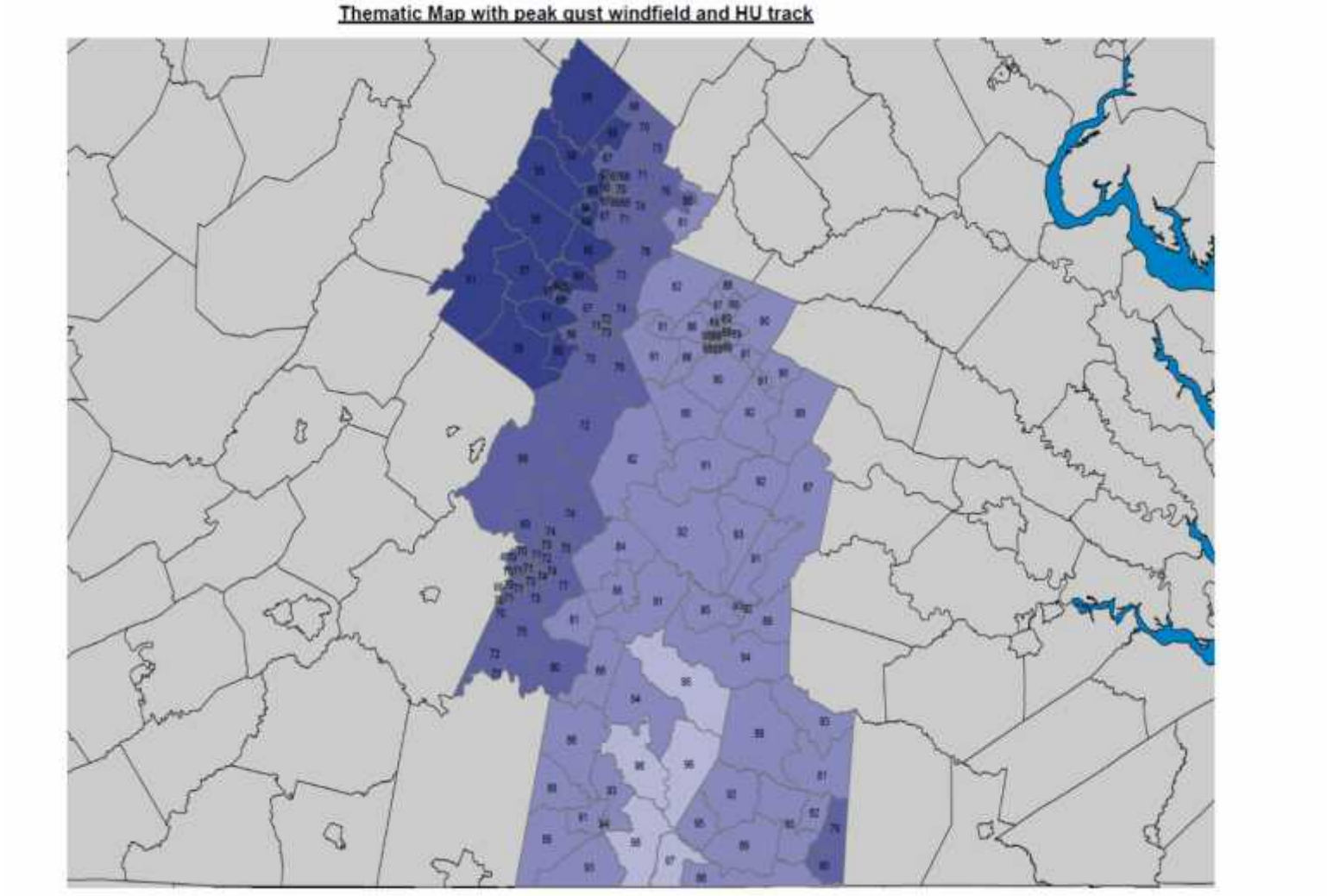


Figure 3.15-16: HAZUS-MH - 100-Year Wind Speeds – VDEM Region 4

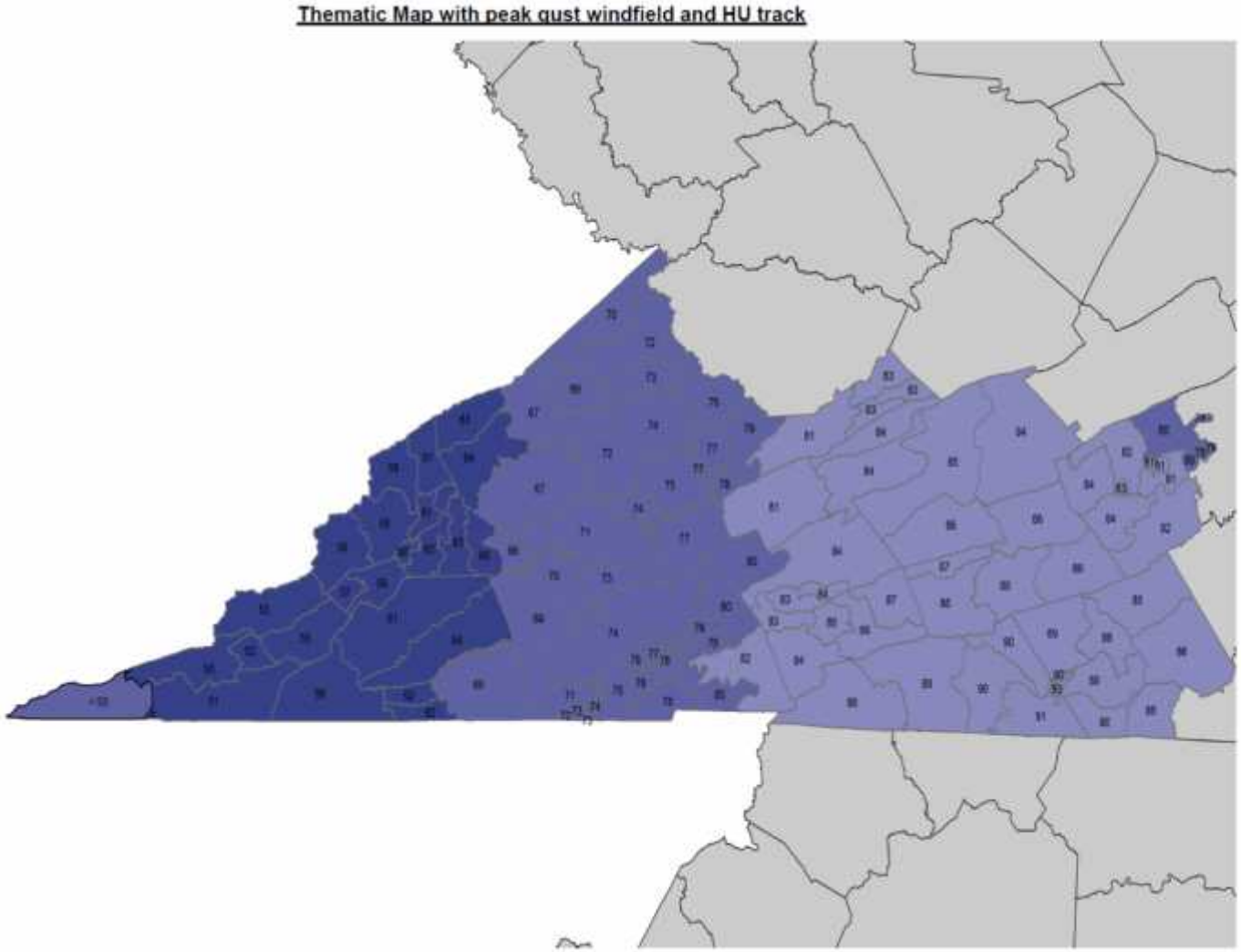


Figure 3.15-17: HAZUS-MH - 100-Year Wind Speeds – VDEM Region 5

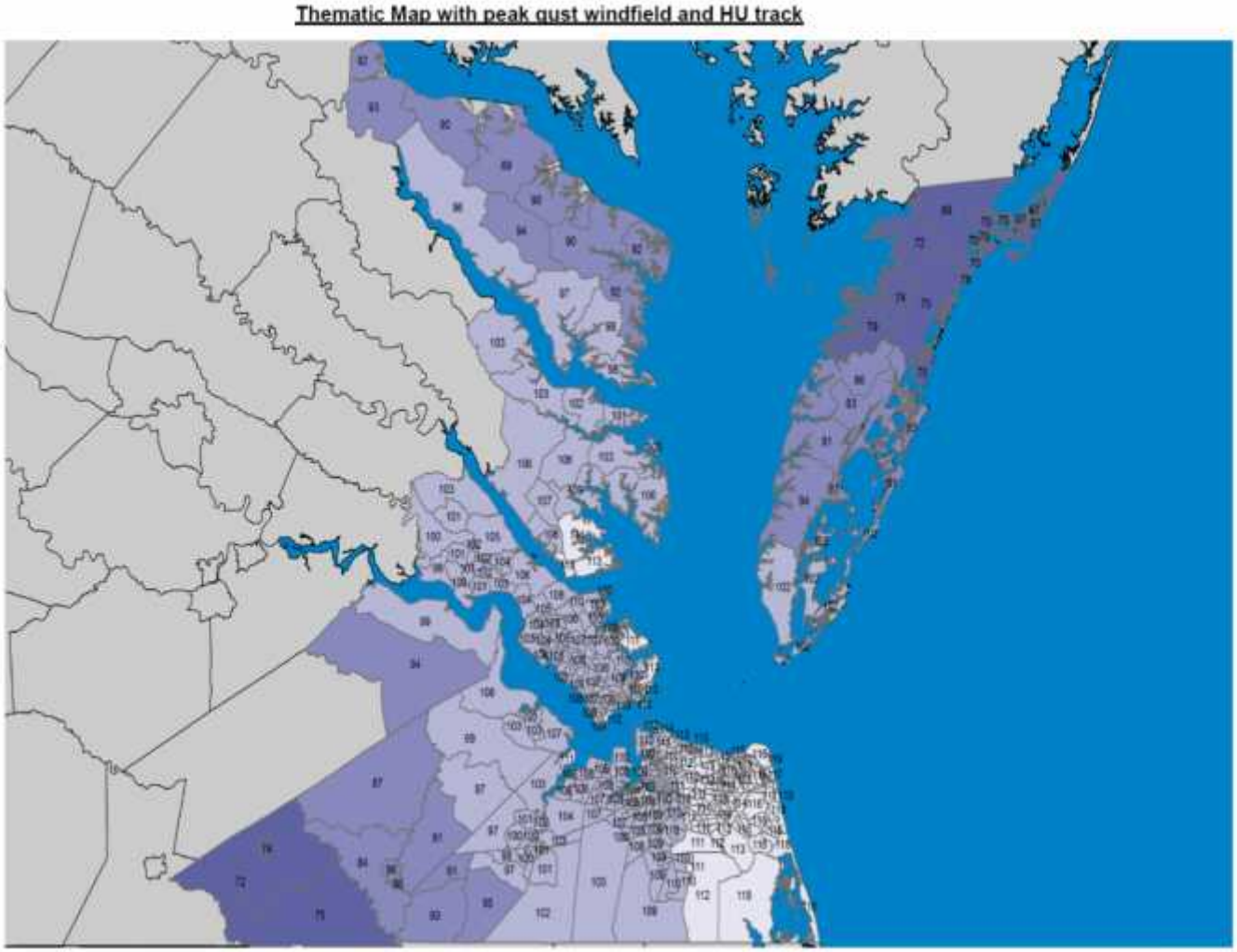


Figure 3.15-18: HAZUS-MH - 100-Year Wind Speeds – VDEM Region 6

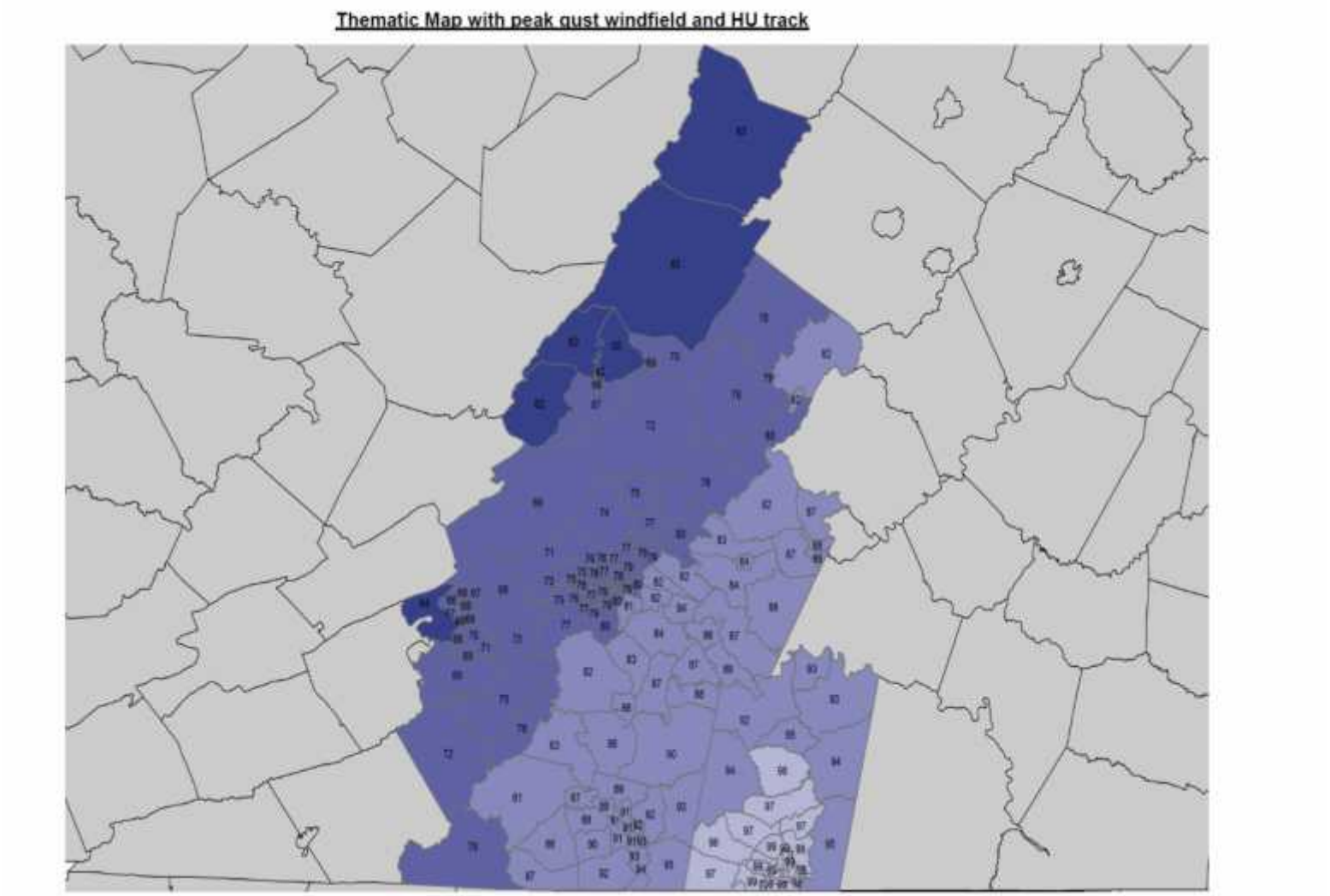
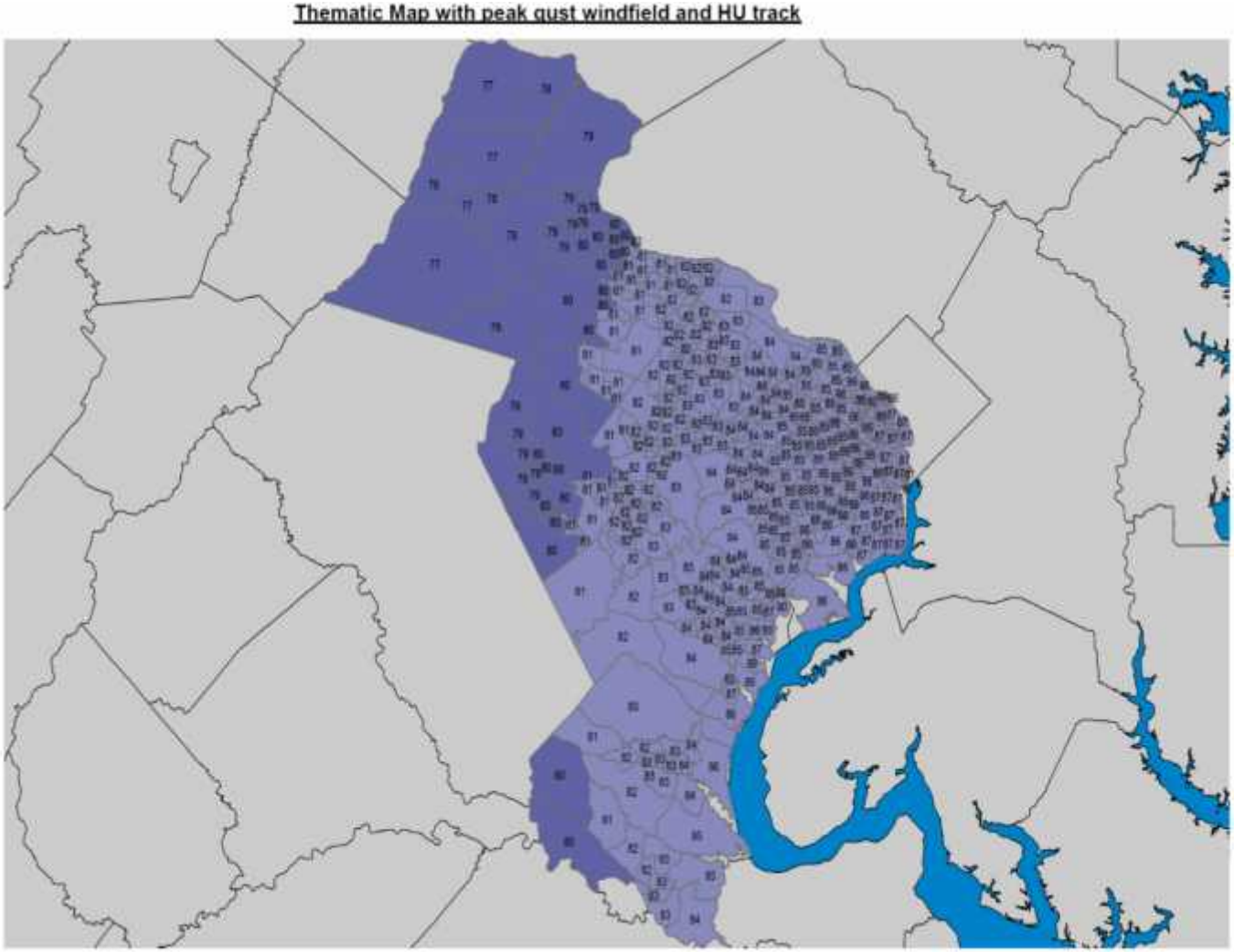


Figure 3.15-19: HAZUS-MH - 100-Year Wind Speeds – VDEM Region 7



Impact & Vulnerability

Vulnerability and impact have been measured in terms of population and property for hurricane winds using 2010 Census tract information. Table 3.15-1 in the *Hurricane Description* section illustrates the potential injuries and damages to property based on different hurricane category events.

The high winds associated with hurricanes may also disrupt the distribution of gasoline, kerosene, diesel fuel, fuel oils, propane and other petroleum products. This disruption could cause major problems for organizations and businesses that rely on such supplies. Additionally, such a disruption could affect backup power generation.

Risk

For this plan update, the risk assessment for non-rotation winds was developed using HAZUS-MH v.3.2. For each VDEM region, a 100-year probabilistic scenario was created and modeled. The results are presented in the following pages, by VDEM region.

For the complete results of each HAZUS-MH scenario, please refer to the appendix.

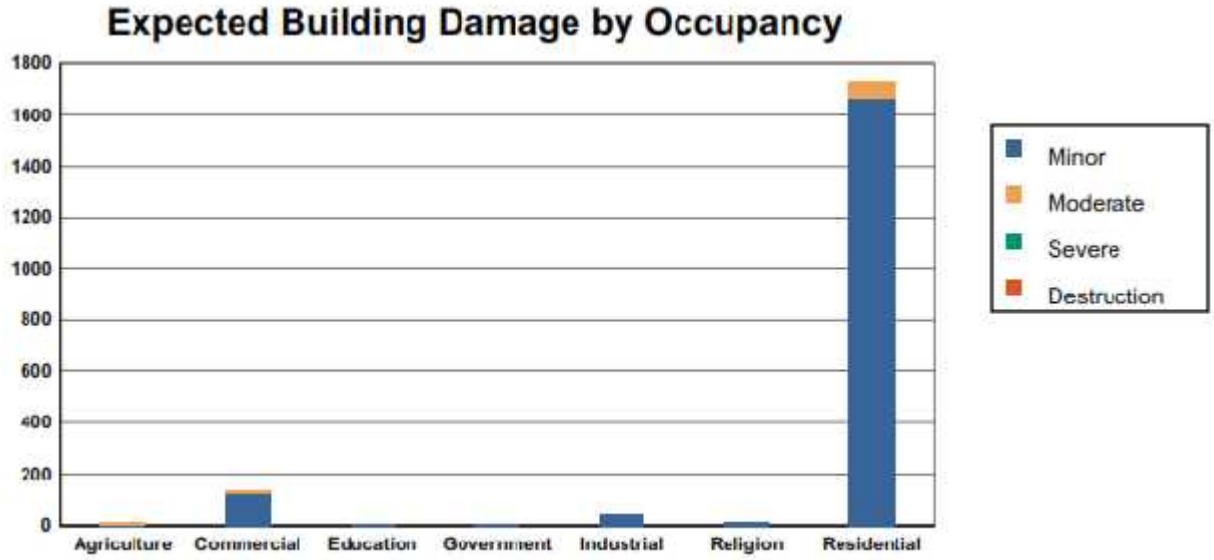
Hurricane HAZUS-MH Model - 100 Year Return Period for VDEM Region 1

The model is based on a probabilistic 100-year return period for VDEM Region 1. VDEM Region 1 includes 22 jurisdictions: Amelia, Brunswick, Charles City, Chesterfield, Dinwiddie, Essex, Goochland, Greensville, Hanover, Henrico, King and Queen, King William, New Kent, Nottoway, Powhatan, Prince George, Sussex, Colonial Heights, Emporia, Hopewell, Petersburg, and Richmond.

Building Damages

HAZUS-MH estimated that at least 65 buildings would be at least moderately damaged by the event; this is less than one percent of the buildings in Virginia. No buildings would be damaged beyond repair. Figure 3.15-20 shows the distribution of damage by type of occupancy.

Figure 3.15-20: VDEM Region 1 Hurricane Scenario – Expected Building Damage by Occupancy (100-Year Probabilistic Event)



As the figure shows, most building damage is expected to be in residential structures. Figure 3.15-21 provides the details of these findings by occupancy type; Figure 3.15-22 provides the details by building type.

Figure 3.15-21: VDEM Region 1 Hurricane Scenario – Expected Building Damage by Occupancy Details (100-Year Probabilistic Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1,498	99.49	7	0.48	0	0.02	0	0.01	0	0.00
Commercial	23,730	99.46	126	0.53	4	0.01	0	0.00	0	0.00
Education	1,111	99.44	6	0.56	0	0.00	0	0.00	0	0.00
Government	991	99.35	6	0.64	0	0.00	0	0.00	0	0.00
Industrial	6,661	99.39	40	0.60	1	0.01	0	0.00	0	0.00
Religion	3,065	99.54	14	0.46	0	0.00	0	0.00	0	0.00
Residential	427,209	99.60	1,670	0.39	60	0.01	0	0.00	0	0.00
Total	**464,205**		**1,870**		**65**		**1**		**0**	

Figure 3.15-22: VDEM Region 1 Hurricane Scenario – Expected Building Damage by Type (100-Year Probabilistic Event)

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	4,277	99.21	34	0.79	0	0.00	0	0.00	0	0.00
Masonry	113,457	99.33	724	0.63	44	0.04	1	0.00	0	0.00
MH	18,093	100.00	1	0.00	0	0.00	0	0.00	0	0.00
Steel	15,810	99.37	104	0.61	2	0.01	0	0.00	0	0.00
Wood	311,542	99.71	892	0.29	11	0.00	0	0.00	0	0.00

Essential Facility Damage

HAZUS-MH estimated that the region has 5,926 hospital beds for use before the hurricane. On the day of the event, HAZUS-MH estimated that 5,926 beds would be available for use by patients already in the hospital and those injured by the hurricane. After seven days, 100 percent of the beds would be in service. Within 30 days, 100 percent would be available. Figure 3.15-23 shows the expected damages to all critical facilities in the region.

Figure 3.15-23: VDEM Region 1 Hurricane Scenario – Expected Damage to Essential Facilities (100-Year Probabilistic Event)

		# Facilities		
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	3	0	0	3
Fire Stations	55	0	0	55
Hospitals	28	15	0	28
Police Stations	57	0	0	57
Schools	410	0	0	410

Debris Generated

As part of the scenario, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. HAZUS-MH estimated that a total of 566,447 tons of debris would be generated by the event. Of that amount, 90 percent would be other tree debris, one percent would be brick/wood, and nine percent would be eligible tree debris. Assuming a load of 25 tons per truck, this would equate to 290 truckloads of debris from this scenario.

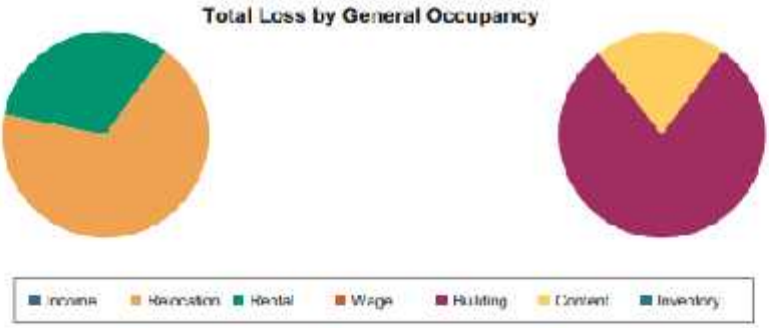
Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that no households would be displaced and no people would seek temporary shelter in the region.

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. HAZUS-MH estimated losses at $177.7 million, which represents less than one percent of the total replacement value of the region's buildings. No losses were related to business interruption in the scenario region. 98 percent of the losses were sustained by residential structures. Figure 3.15-24 provides additional details of these estimated losses.

Figure 3.15-24: VDEM Region 1 Hurricane Scenario – Economic Loss (100-Year Probabilistic Event)



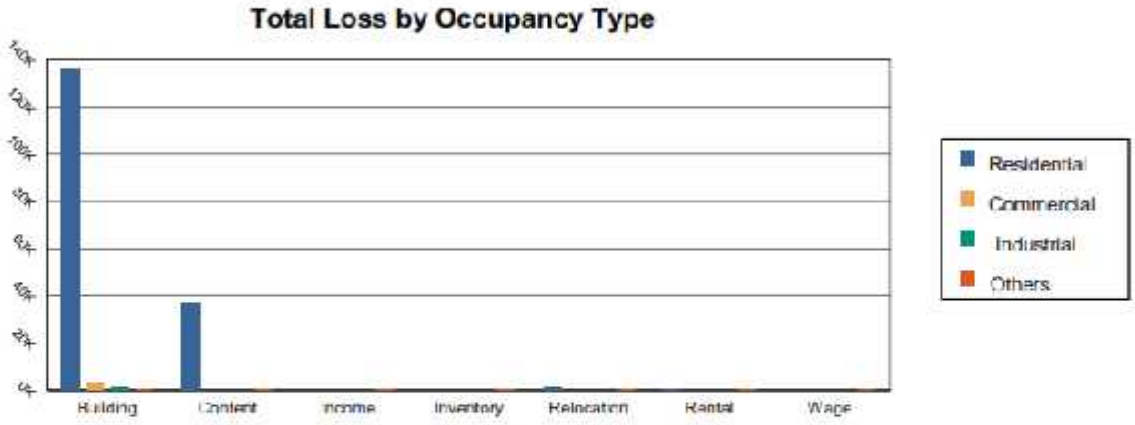


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	136,430.51	2,274.53	724.85	627.25	140,057.14
	Content	36,456.59	2.83	22.13	2.01	36,483.56
	Inventory	0.00	0.22	4.56	0.25	5.05
	Subtotal	**172,887.10**	**2,277.33**	**750.75**	**629.51**	**176,524.76**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	769.76	22.90	0.27	1.18	794.12
	Rental	370.79	0.00	0.00	0.00	370.79
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**1,140.55**	**22.90**	**0.27**	**1.18**	**1,164.90**
Total						
	Total	**174,027.65**	**2,300.23**	**751.03**	**630.73**	**177,689.66**

Hurricane HAZUS-MH Model - 100 Year Return Period for VDEM Region 2

The model is based on a probabilistic 100-year return period for VDEM Region 2. VDEM Region 2 includes 17 jurisdictions: Caroline, Clarke, Culpeper, Fauquier, Frederick, Greene, King George, Louisa, Madison, Orange, Page, Rappahannock, Shenandoah, Spotsylvania, Warren, Fredericksburg, and Winchester.

Building Damages

HAZUS-MH estimated that at least two buildings would be at least moderately damaged by the event; this is less than one percent of the buildings in Virginia. No buildings would be damaged beyond repair. Figure 3.15-25 shows the distribution of damage by type of occupancy.

Figure 3.15-25: VDEM Region 2 Hurricane Scenario – Expected Building Damage by Occupancy (100-Year Probabilistic Event)

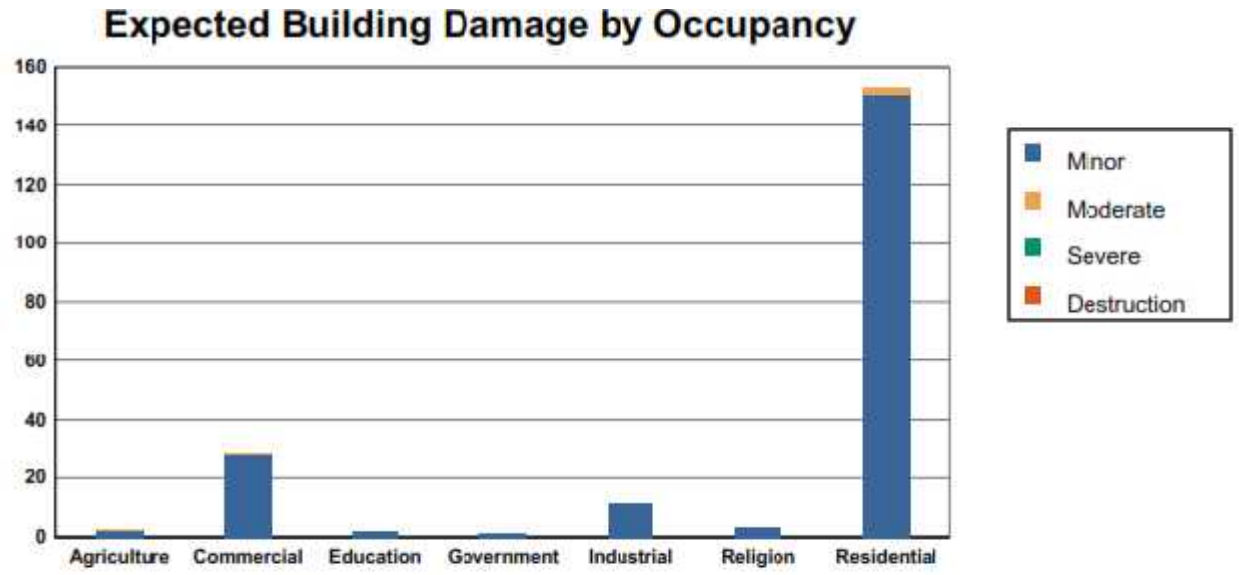


Table 2: Expected Building Damage by Occupancy : 100 - year Event

As the figure shows, most building damage is expected to be to residential structures. Figure 3.15-26 provides the details of these findings by occupancy type; Figure 3.15-27 provides the details by building type.

Figure 3.15-26: VDEM Region 2 Hurricane Scenario – Expected Building Damage by Occupancy Details (100-Year Probabilistic Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1,273	99.82	2	0.18	0	0.00	0	0.00	0	0.00
Commercial	12,057	99.77	28	0.23	0	0.00	0	0.00	0	0.00
Education	550	99.74	1	0.26	0	0.00	0	0.00	0	0.00
Government	429	99.75	1	0.25	0	0.00	0	0.00	0	0.00
Industrial	4,002	99.73	11	0.27	0	0.00	0	0.00	0	0.00
Religion	1,512	99.80	3	0.20	0	0.00	0	0.00	0	0.00
Residential	245,198	99.94	151	0.06	2	0.00	0	0.00	0	0.00
Total	**265,080**		**198**		**2**		**0**		**0**	

Figure 3.15-27: VDEM Region 2 Hurricane Scenario – Expected Building Damage by Type (100-Year Probabilistic Event)

Building	None		Minor		Moderate		Severe		Destruction	
Type	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	2,027	99.67	7	0.33	0	0.00	0	0.00	0	0.00
Masonry	63,231	99.86	87	0.14	1	0.00	0	0.00	0	0.00
MH	15,009	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	8,949	99.72	25	0.27	0	0.00	0	0.00	0	0.00
Wood	175,800	99.96	75	0.04	1	0.00	0	0.00	0	0.00

Essential Facility Damage

HAZUS-MH estimated that the region has 1,078 hospital beds for use before the hurricane. On the day of the event, HAZUS-MH estimated that 1,078 beds would be available for use by patients already in the hospital and those injured by the hurricane. After seven days, 100 percent of the beds would be in service. Figure 3.15-28 shows the expected damages to all critical facilities in the region.

Figure 3.15-28: VDEM Region 2 Hurricane Scenario – Expected Damage to Essential Facilities (100-Year Probabilistic Event)

		# Facilities		
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
Fire Stations	98	0	0	98
Hospitals	7	0	0	7
Police Stations	46	0	0	46
Schools	215	0	0	215

Debris Generated

As part of the model, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. HAZUS-MH estimated that a total of 144,237 tons of debris would be generated by the event. Of that amount, 92 percent would be other tree debris, four percent would be brick/wood, and four percent eligible tree debris. Assuming a load of 25 tons per truck, this would equate to 19 truckloads of debris from this scenario.

Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that no households would be displaced and no people would seek temporary shelter in public shelters.

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. HAZUS-MH estimated losses at $38.9 million, which represents one half percent of the total replacement value of the region's buildings. None of the losses were related to business interruption in the scenario region. 99 percent of the losses were sustained by residential structures. Figure 3.15-29 provides additional details of these estimated losses.

Figure 3.15-29: VDEM Region 2 Hurricane Scenario – Economic Loss (100-Year Probabilistic Event)



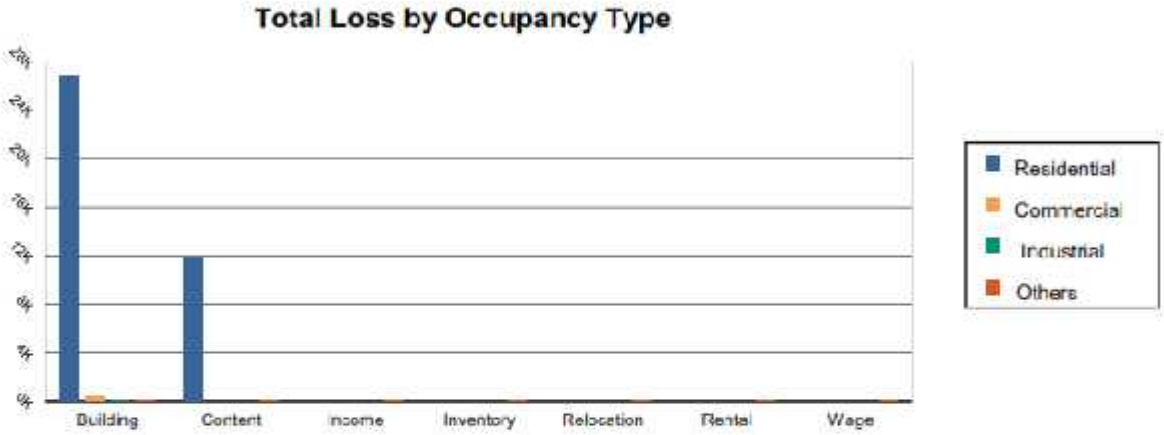


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	26,601.48	315.19	61.81	68.25	27,136.73
	Content	11,754.90	0.00	0.00	0.00	11,754.90
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**38,476.38**	**315.19**	**61.81**	**68.25**	**38,921.63**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	6.80	0.47	0.00	0.04	7.40
	Rental	1.53	0.00	0.00	0.00	1.53
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**8.42**	**0.47**	**0.00**	**0.04**	**8.93**
Total						
	Total	**38,484.81**	**315.66**	**61.81**	**68.29**	**38,930.56**

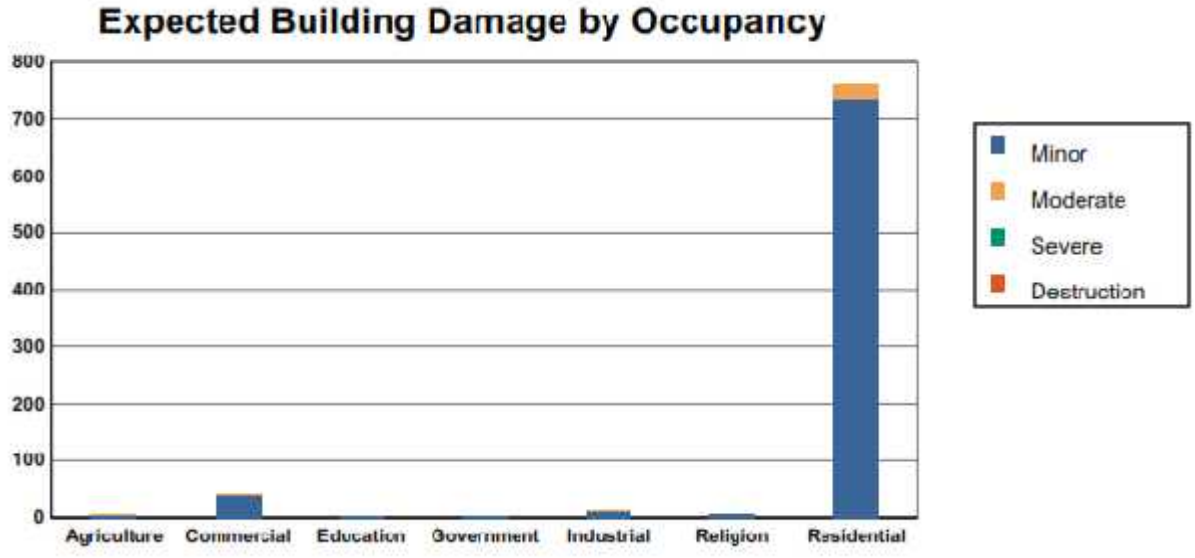
Hurricane HAZUS-MH Model- 100 Year Return Period for VDEM Region 3

The model is based on a probabilistic 100-year return period for VDEM Region 3. VDEM Region 3 includes 20 jurisdictions: Albemarle, Amherst, Appomattox, Augusta, Buckingham, Campbell, Charlotte, Cumberland, Fluvanna, Halifax, Lunenburg, Mecklenburg, Nelson, Prince Edward, Rockingham, Charlottesville, Harrisonburg, Lynchburg, Staunton, and Waynesboro.

Building Damages

HAZUS-MH estimated that at least 30 buildings would be at least moderately damaged by the event; this is less than one percent of the buildings in Virginia. No buildings would be damaged beyond repair. Figure 3.15-30 shows the distribution of damage by type of occupancy.

Figure 3.15-30: VDEM Region 3 Hurricane Scenario – Expected Building Damage by Occupancy (100-Year Probabilistic Event)



As the figure shows, most building damage was found to be in residential structures. Figure 3.15-31 provides the details of these findings by occupancy type; Figure 3.15-32 provides the details by building type.

Figure 3.15-31: VDEM Region 3 Hurricane Scenario – Expected Building Damage by Occupancy Details (100-Year Probabilistic Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1,555	99.67	5	0.29	0	0.02	0	0.01	0	0.00
Commercial	14,545	99.71	40	0.27	2	0.01	0	0.00	0	0.00
Education	783	99.73	2	0.27	0	0.00	0	0.00	0	0.00
Government	550	99.62	2	0.37	0	0.00	0	0.00	0	0.00
Industrial	4,333	99.70	13	0.29	0	0.01	0	0.00	0	0.00
Religion	2,246	99.72	6	0.27	0	0.00	0	0.00	0	0.00
Residential	287,127	99.74	735	0.26	26	0.01	0	0.00	0	0.00
Total	**311,138**		**802**		**29**		**0**		**0**	

Figure 3.15-32: VDEM Region 3 Hurricane Scenario – Expected Building Damage by Type (100-Year Probabilistic Event)

Building	None		Minor		Moderate		Severe		Destruction	
Type	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	2,887	99.62	11	0.38	0	0.01	0	0.00	0	0.00
Masonry	70,192	99.66	226	0.32	12	0.02	1	0.00	0	0.00
MH	35,817	99.99	2	0.00	0	0.00	0	0.00	0	0.00
Steel	10,889	99.68	33	0.30	2	0.01	0	0.00	0	0.00
Wood	191,363	99.75	453	0.24	12	0.01	0	0.00	0	0.00

Essential Facility Damage

HAZUS-MH estimated that the region has 3,769 hospital beds for use before the hurricane. On the day of the event, HAZUS-MH estimated that 3,769 beds would be available for use by patients already in the hospital and those injured by the hurricane. After seven days, 100 percent of the beds would be in service. Figure 3.15-33 shows the expected damages to all critical facilities in the region.

Figure 3.15-33 VDEM Region 3 Hurricane Scenario – Expected Damage to Essential Facilities (100-Year Probabilistic Event)

		# Facilities		
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	1	0	0	1
Fire Stations	117	0	0	117
Hospitals	13	1	0	13
Police Stations	56	0	0	56
Schools	293	0	0	293

Debris Generated

As part of the model, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. HAZUS-MH estimated that a total of 581,703 tons of debris would be generated by the event. Of that amount, 93 percent would be other tree debris, five percent would be brick/wood, and two percent eligible tree debris. Assuming a load of 25 tons per truck, this would equate to 78 truckloads of debris from this scenario.

Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that one household would be displaced, but that no people would seek temporary shelter in public shelters.

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. HAZUS-MH estimated losses at $50 million, which represents approximately one half percent of the total replacement value of the region's buildings. No losses were related to business interruption in the scenario region. 99 percent of the losses were sustained by residential structures. Figure 3.15-34 provides additional details of these estimated losses.

Figure 3.15-34: VDEM Region 3 Hurricane Scenario – Economic Loss (100-Year Probabilistic Event)



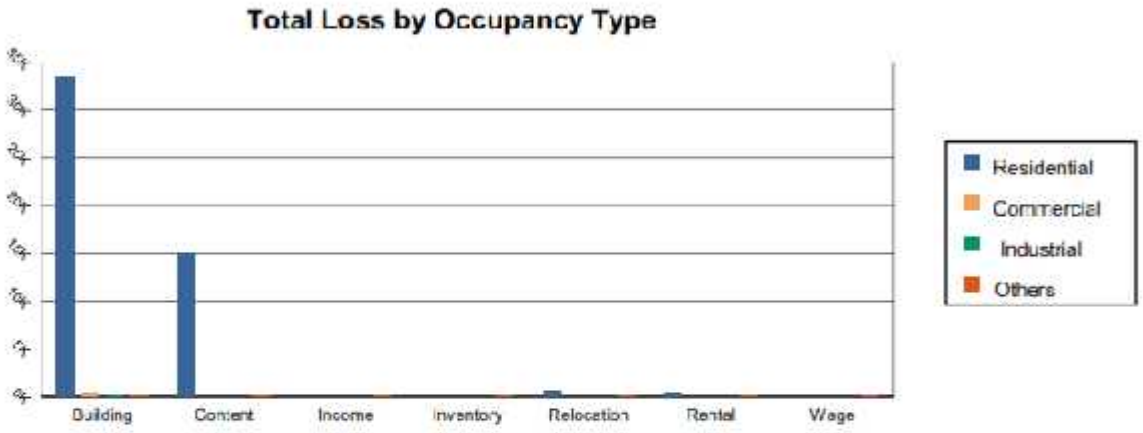


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	33,468.10	319.95	108.27	140.19	34,036.51
	Content	14,980.32	4.57	18.30	6.54	15,009.68
	Inventory	0.00	0.26	3.86	0.32	5.04
	Subtotal	**48,448.42**	**324.73**	**130.44**	**147.04**	**49,051.23**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00	
	Relocation	667.87	9.45	0.75	1.79	949.86	
	Rental	244.23	0.00	0.00	0.00	244.23	
	Wage	0.00	0.00	0.00	0.00	0.00	
	Subtotal	**932.10**	**9.45**	**0.75**	**1.79**	**944.10**	
Total						
	Total	**49,380.53**	**334.19**	**131.19**	**149.43**	**49,995.33**	

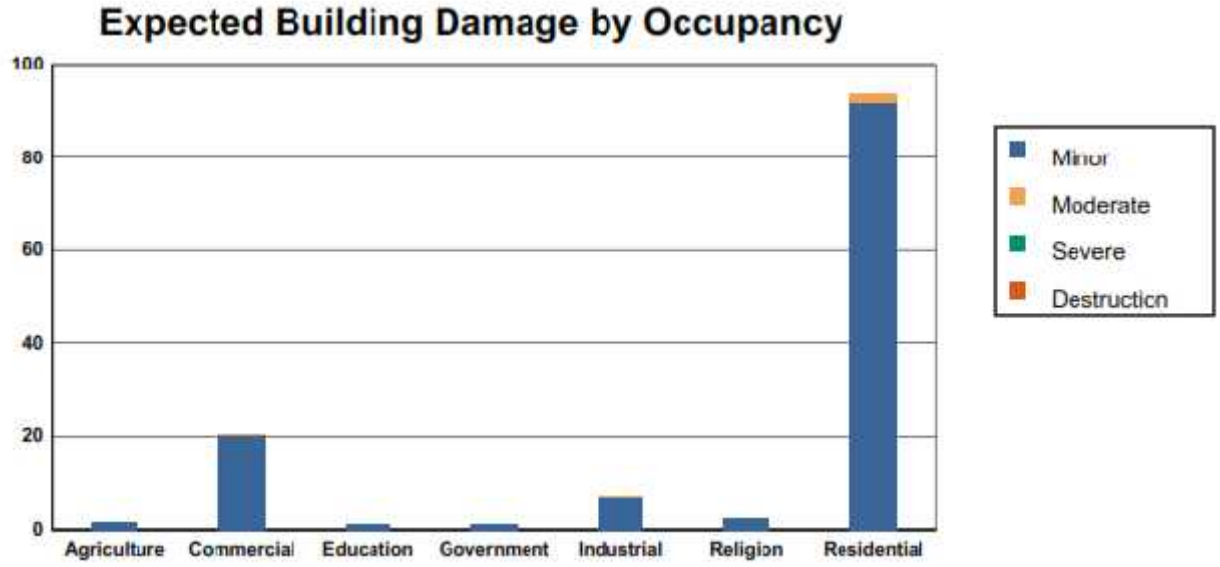
Hurricane HAZUS-MH Model- 100 Year Return Period for VDEM Region 4

The model is based on a probabilistic 100-year return period for VDEM Region 4. VDEM Region 4 includes 18 jurisdictions: Bland, Buchanan, Carroll, Dickenson, Grayson, Lee, Pulaski, Russell, Scott, Smyth, Tazewell, Washington, Wise, Wythe, Bristol, Galax, Norton, and Radford.

Building Damages

HAZUS-MH estimated that at least two buildings would be at least moderately damaged by the event; this is less than one percent of the buildings in Virginia. No buildings would be damaged beyond repair. Figure 3.15-35 shows the distribution of damage by type of occupancy.

Figure 3.15-35: VDEM Region 4 Hurricane Scenario – Expected Building Damage by Occupancy (100-Year Probabilistic Event)



As the figure shows, most building damage was found to be in residential structures. Figure 3.15-36 provides the details of these findings by occupancy type; Figure 3.15-37 provides the details by building type.

Figure 3.15-36: VDEM Region 4 Hurricane Scenario – Expected Building Damage by Occupancy Details (100-Year Probabilistic Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	623	99.79	1	0.21	0	0.00	0	0.00	0	0.00
Commercial	7,839	99.74	20	0.26	0	0.00	0	0.00	0	0.00
Education	446	99.74	1	0.26	0	0.00	0	0.00	0	0.00
Government	433	99.73	1	0.27	0	0.00	0	0.00	0	0.00
Industrial	2,322	99.69	7	0.31	0	0.00	0	0.00	0	0.00
Religion	1,123	99.80	2	0.20	0	0.00	0	0.00	0	0.00
Residential	201,234	99.95	92	0.05	2	0.00	0	0.00	0	0.00
Total	**214,018**		**125**		**2**		**0**		**0**	

Figure 3.25-37: VDEM Region 4 Hurricane Scenario – Expected Building Damage by Type (100-Year Probabilistic Event)

Building	None		Minor		Moderate		Severe		Destruction	
Type	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	1,425	99.63	5	0.37	0	0.00	0	0.00	0	0.00
Masonry	42,253	99.84	67	0.16	1	0.00	0	0.00	0	0.00
MH	47,356	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	5,829	99.70	18	0.30	0	0.00	0	0.00	0	0.00
Wood	117,094	99.98	28	0.02	0	0.00	0	0.00	0	0.00

Essential Facility Damage

HAZUS-MH estimated that the region has 1,920 hospital beds for use before the hurricane. On the day of the event, HAZUS-MH estimated that 1,920 beds would be available for use by patients already in the hospital and those injured by the hurricane. After seven days, 100 percent of the beds would be in service. Figure 3.15-38 shows the expected damages to all critical facilities in the region.

Figure 3.15-38: VDEM Region 4 Hurricane Scenario – Expected Damage to Essential Facilities (100-Year Probabilistic Event)

		# Facilities		
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	2	0	0	2
Fire Stations	90	0	0	90
Hospitals	18	1	0	18
Police Stations	57	0	0	57
Schools	218	0	0	218

Debris Generated

As part of the model, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. HAZUS-MH estimated that a total of 699 tons of debris would be generated by the event. Of that amount, 33 percent would be other tree debris, 65 percent would be brick/wood, and two percent eligible tree debris. Assuming a load of 25 tons per truck, this would equate to 12 truckloads of debris from this scenario.

Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that no households would be displaced, and no people would be expected to seek temporary shelter in public shelters.

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. HAZUS-MH estimated losses at $7.7 million, which represents less than one half percent of the total replacement value of the region's buildings. One percent of the losses were related to business interruption in the scenario region. 95 percent of the losses were sustained by residential structures. Figure 3.15-39 provides additional details of these estimated losses.

Figure 3.15-39: VDEM Region 4 Hurricane Scenario – Economic Loss (100-Year Probabilistic Event)



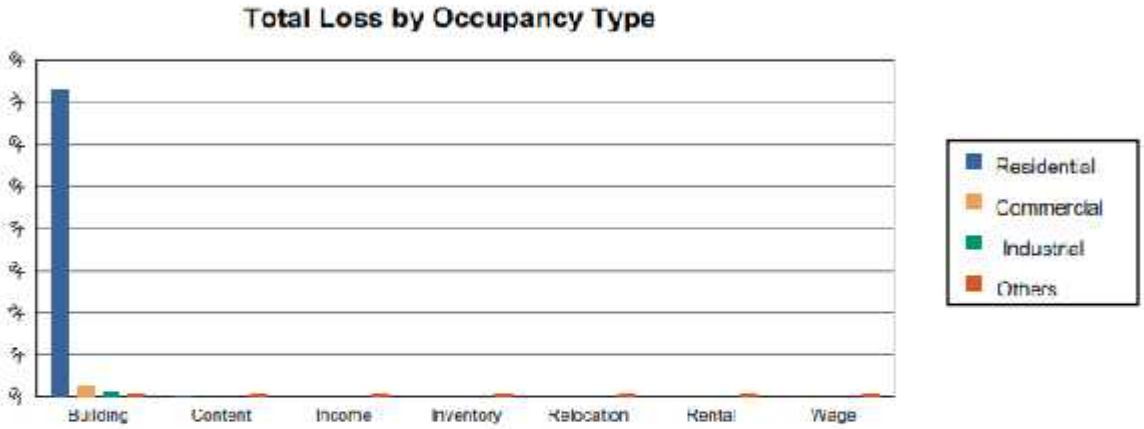


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	7,284.03	244.65	90.57	65.44	7,584.69
	Content	19.10	0.00	0.00	0.00	19.10
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**7,303.13**	**244.65**	**90.57**	**65.44**	**7,703.85**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	4.19	0.70	0.00	0.01	4.90
	Rental	3.10	0.00	0.00	0.00	3.10
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**7.29**	**0.70**	**0.00**	**0.01**	**8.00**
Total						
	Total	**7,310.47**	**245.35**	**90.57**	**65.46**	**7,711.85**

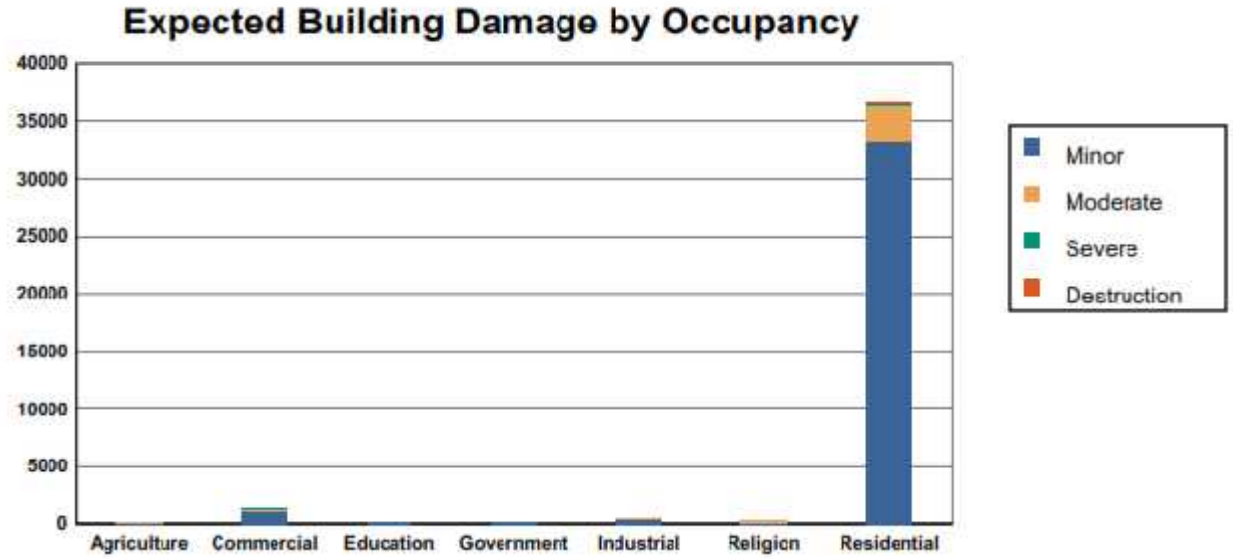
Hurricane HAZUS-MH Model- 100 Year Return Period for VDEM Region 5

The model is based on a probabilistic 100-year return period for VDEM Region 5. VDEM Region 5 includes 24 jurisdictions: Accomack, Gloucester, Isle of Wight, James City, Lancaster, Mathews, Middlesex, Northampton, Northumberland, Richmond, Southampton, Surry, Westmoreland, York, Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg.

Building Damages

HAZUS-MH estimated that at least 3,611 buildings would be at least moderately damaged by the event; this is more than one percent of the buildings in Virginia. 38 buildings would be damaged beyond repair. Figure 3.15-40 shows the distribution of damage by type of occupancy.

Figure 3.15-40: VDEM Region 5 Hurricane Scenario – Expected Building Damage by Occupancy (100-Year Probabilistic Event)



As the figure shows, most building damage was found to be in residential structures. Figure 3.15-41 provides the details of these findings by occupancy type; Figure 3.15-42 provides the details by building type.

Figure 3.15-42: VDEM Region 5 Hurricane Scenario – Expected Building Damage by Occupancy Details (100-Year Probabilistic Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1,821	94.88	80	4.16	13	0.67	5	0.26	0	0.01
Commercial	31,008	95.42	1,297	3.99	174	0.53	16	0.05	0	0.00
Education	1,469	95.72	61	4.00	4	0.28	0	0.00	0	0.00
Government	1,228	95.64	52	4.04	4	0.31	0	0.00	0	0.00
Industrial	7,909	95.44	333	4.02	37	0.44	7	0.09	0	0.00
Religion	3,775	95.62	162	4.10	10	0.26	0	0.01	0	0.00
Residential	568,533	93.97	33,169	5.48	3,250	0.54	42	0.01	37	0.01
Total	**615,744**		**35,154**		**3,502**		**72**		**38**	

Figure 3.15-43: VDEM Region 5 Hurricane Scenario – Expected Building Damage by Type (100-Year Probabilistic Event)

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	5,913	94.18	333	5.30	32	0.51	0	0.00	0	0.00
Masonry	149,035	92.88	9,556	5.96	1,826	1.14	36	0.02	6	0.00
MH	26,024	99.84	34	0.13	7	0.03	0	0.00	1	0.00
Steel	21,701	95.39	904	3.98	131	0.58	14	0.06	0	0.00
Wood	414,237	94.41	23,234	5.30	1,236	0.28	38	0.01	23	0.01

Essential Facility Damage

HAZUS-MH estimated that the region has 5,844 hospital beds for use before the hurricane. On the day of the event, HAZUS-MH estimated that 5,391 beds would be available for use by patients already in the hospital and those injured by the hurricane. After seven days, 100 percent of the beds would be in service. Figure 3.15-44 shows the expected damages to all critical facilities in the region.

Figure 3.15-44: VDEM Region 5 Hurricane Scenario – Expected Damage to Essential Facilities (100-Year Probabilistic Event)

		# Facilities		
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	6	0	0	6
Fire Stations	94	0	0	94
Hospitals	28	17	0	25
Police Stations	77	0	0	77
Schools	611	0	0	611

Debris Generated

As part of the model, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. HAZUS-MH estimated that a total of 1,550,298 tons of debris would be generated by the event. Of that amount, 77 percent would be other tree debris, eight percent would be brick/wood, and 15 percent eligible tree debris. Assuming a load of 25 tons per truck, this would equate to 4,924 truckloads of debris from this scenario.

Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that 838 households would be displaced. Of these, 205 people would be expected to seek temporary shelter in public shelters. Based on the 2010 Census population of 1,782,229, this equates to one-tenth percent of the region's population.

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. HAZUS-MH estimated losses at $1.845 billion, which represents almost one percent of the total replacement value of the region's buildings. One percent of the losses were related to business interruption in the scenario region. 96 percent of the losses were sustained by residential structures. Figure 3.15-45 provides additional details of these estimated losses.

Figure 3.15-45: VDEM Region 5 Hurricane Scenario – Economic Loss (100-Year Probabilistic Event)



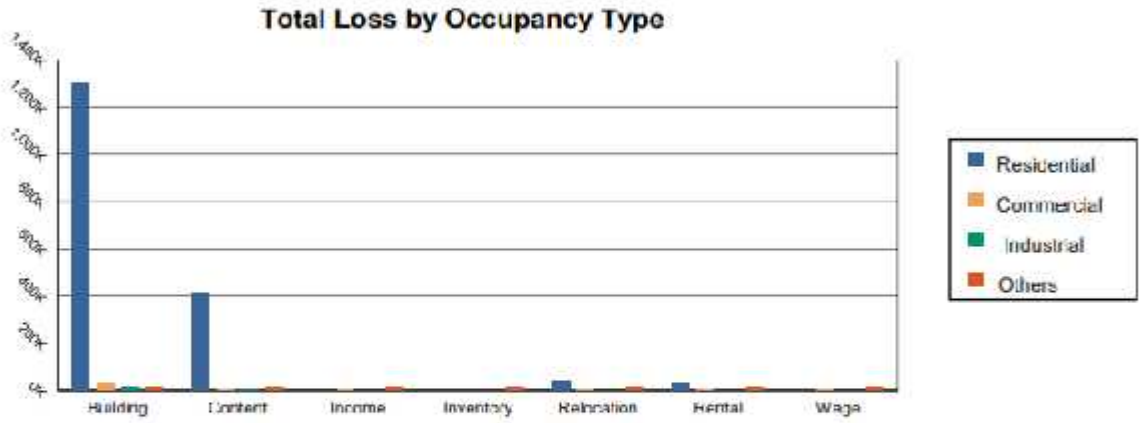


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	1,298,783.35	31,840.91	6,887.82	8,401.03	1,346,012.90
	Content	408,876.35	5,170.88	2,914.91	1,204.26	418,166.40
	Inventory	0.00	133.29	552.77	41.01	727.07
	Subtotal	**1,706,660.70**	**37,145.08**	**10,455.30**	**9,646.30**	**1,762,606.37**
Business Interruption Loss						
	Income	0.00	4,048.70	45.25	844.97	4,938.93
	Relocation	38,107.29	4,114.39	237.05	844.55	43,303.28
	Rental	25,694.84	2,160.59	39.21	73.15	27,967.78
	Wage	0.00	3,913.69	74.84	2,378.89	6,367.41
	Subtotal	**63,832.13**	**14,235.35**	**396.36**	**4,141.56**	**82,605.40**
Total						
	Total	**1,760,491.82**	**51,380.43**	**10,851.66**	**13,787.86**	**1,846,511.77**

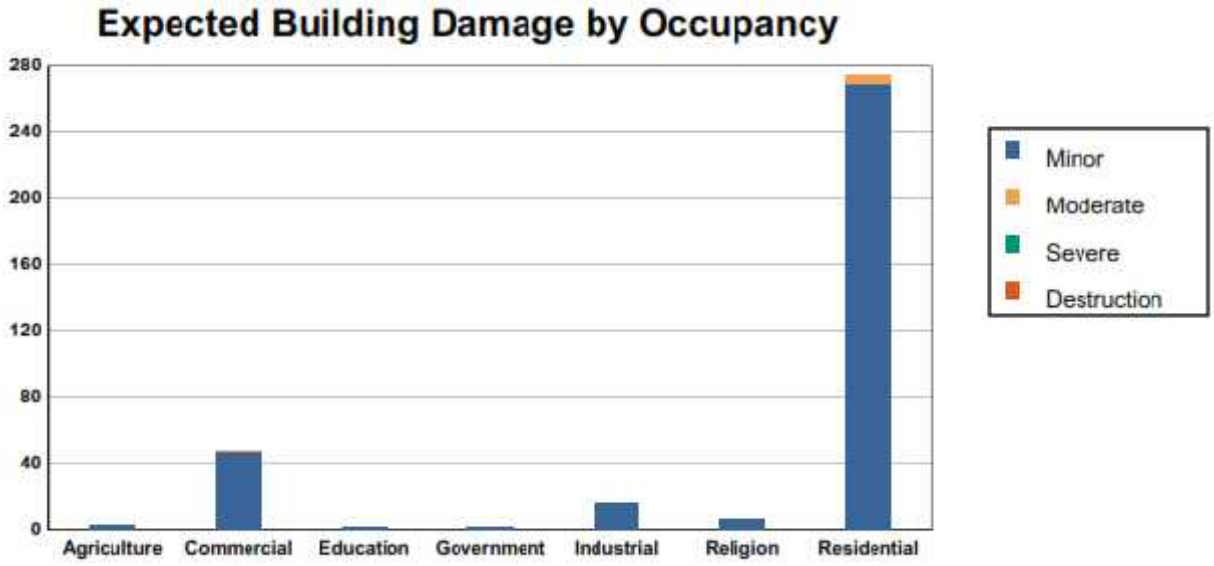
Hurricane HAZUS-MH Model- 100 Year Return Period for VDEM Region 6

The model is based on a probabilistic 100-year return period for VDEM Region 6. VDEM Region 6 includes 22 jurisdictions: Alleghany, Bath, Bedford, Botetourt, Craig, Floyd, Franklin, Henry, Highland, Highland, Montgomery, Patrick, Pittsylvania, Roanoke, Rockbridge, Bedford, Buena Vista, Covington, Danville, Lexington, Martinsville, Roanoke, and Salem.

Building Damages

HAZUS-MH estimated that at least five buildings would be at least moderately damaged by the event; this is a negligible percentage of the buildings in Virginia. No buildings would be damaged beyond repair. Figure 3.15-46 shows the distribution of damage by type of occupancy.

Figure 3.15-46: VDEM Region 6 Hurricane Scenario – Expected Building Damage by Occupancy (100-Year Probabilistic Event)



As the figure shows, most building damage was found to be in residential structures. Figure 3.15-47 provides the details of these findings by occupancy type; Figure 3.15-48 provides the details by building type.

Figure 3.15-47: VDEM Region 6 Hurricane Scenario – Expected Building Damage by Occupancy Details (100-Year Probabilistic Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1,194	99.77	3	0.23	0	0.00	0	0.00	0	0.00
Commercial	16,539	99.71	47	0.28	0	0.00	0	0.00	0	0.00
Education	781	99.71	2	0.29	0	0.00	0	0.00	0	0.00
Government	559	99.67	2	0.33	0	0.00	0	0.00	0	0.00
Industrial	4,829	99.67	16	0.33	0	0.00	0	0.00	0	0.00
Religion	2,547	99.76	6	0.24	0	0.00	0	0.00	0	0.00
Residential	311,470	99.91	269	0.09	5	0.00	0	0.00	0	0.00
Total	**337,919**		**345**		**5**		**0**		**0**	

Figure 3.25-48: VDEM Region 6 Hurricane Scenario – Expected Building Damage by Type (100-Year Probabilistic Event)

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	2,966	99.59	12	0.41	0	0.00	0	0.00	0	0.00
Masonry	76,039	99.77	169	0.22	4	0.01	0	0.00	0	0.00
MH	39,330	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	11,912	99.66	40	0.33	0	0.00	0	0.00	0	0.00
Wood	207,655	99.95	103	0.05	0	0.00	0	0.00	0	0.00

Essential Facility Damage

HAZUS-MH estimated that the region has 2,717 hospital beds for use before the hurricane. On the day of the event, HAZUS-MH estimated that 2,717 beds would be available for use by patients already in the hospital and those injured by the hurricane. After seven days, 100 percent of the beds would be in service. Figure 3.15-49 shows the expected damages to all critical facilities in the region.

Figure 3.15-49: VDEM Region 6 Hurricane Scenario – Expected Damage to Essential Facilities (100-Year Probabilistic Event)

		# Facilities		
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	4	0	0	4
Fire Stations	95	0	0	95
Hospitals	15	3	0	15
Police Stations	42	0	0	42
Schools	288	0	0	288

Debris Generated

As part of the model, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. HAZUS-MH estimated that a total of 46,413 tons of debris would be generated by the event. Of that amount, 86 percent would be other tree debris, almost three percent would be brick/wood, and 11.2 percent eligible tree debris. Assuming a load of 25 tons per truck, this would equate to 51 truckloads of debris from this scenario.

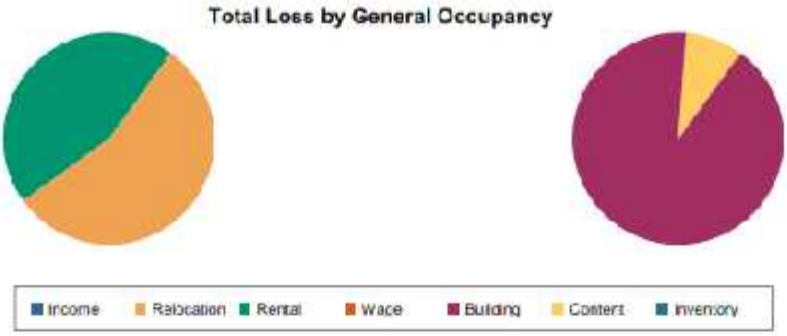
Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that no households would be displaced, and no residents would be expected to seek temporary shelter in public shelters.

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. HAZUS-MH estimated losses at $28.1 million, which represents approximately one quarter percent of the total replacement value of the region's buildings. One percent of the losses were related to business interruption in the scenario region. 97 percent of the losses were sustained by residential structures. Figure 3.15-50 provides additional details of these estimated losses.

Figure 3.15-50: VDEM Region 6 Hurricane Scenario – Economic Loss (100-Year Probabilistic Event)



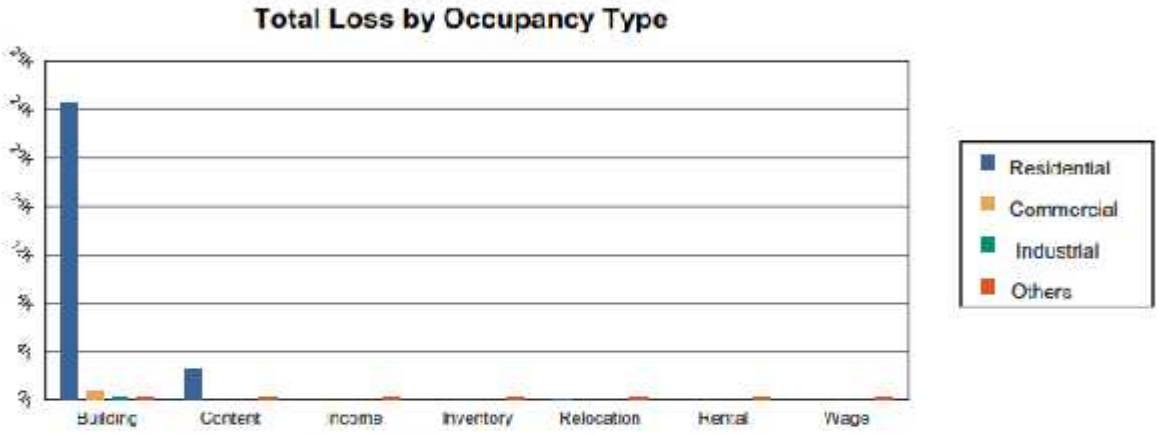


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	24,609.91	614.99	132.09	159.86	25,566.85
	Content	2,456.97	0.00	0.00	0.00	2,456.97
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**27,066.88**	**614.99**	**132.09**	**159.86**	**28,023.82**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	18.31	2.38	0.00	0.05	20.74
	Rental	16.95	0.00	0.00	0.00	16.95
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**35.26**	**2.38**	**0.00**	**0.05**	**37.69**
Total						
	Total	**27,102.14**	**617.37**	**132.09**	**159.91**	**28,061.51**

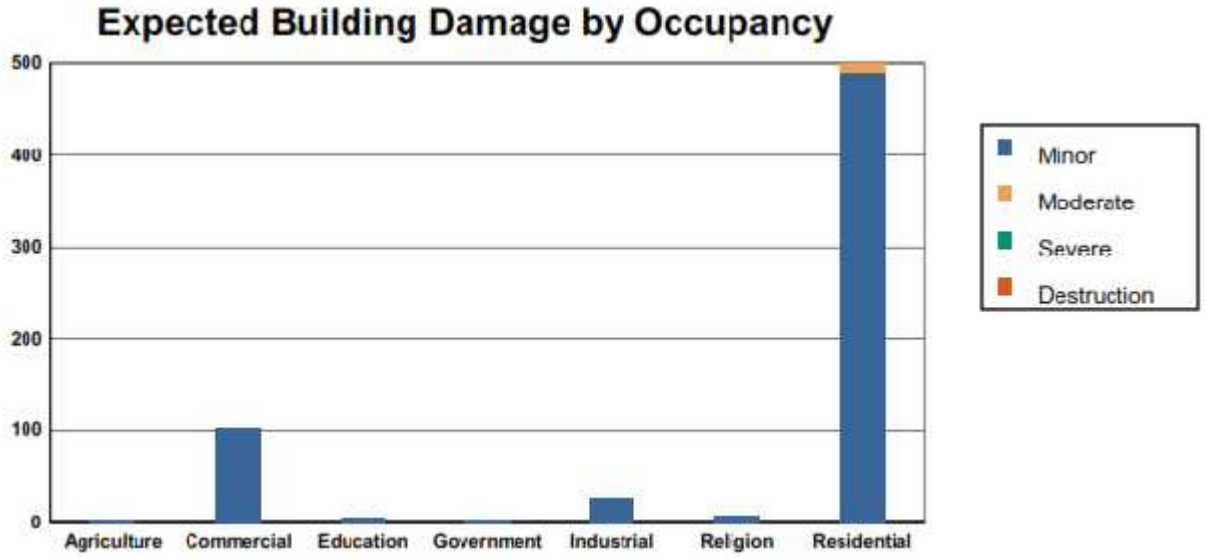
Hurricane HAZUS-MH Model- 100 Year Return Period for VDEM Region 7

The model is based on a probabilistic 100-year return period for VDEM Region 7. VDEM Region 7 includes 10 jurisdictions: Arlington, Fairfax, Loudoun, Prince William, Stafford, Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park.

Building Damages

HAZUS-MH estimated that at least ten buildings would be at least moderately damaged by the event; this a negligible percentage of the buildings in Virginia. No buildings would be damaged beyond repair. Figure 3.15-51 shows the distribution of damage by type of occupancy.

Figure 3.15-51: VDEM Region 7 Hurricane Scenario – Expected Building Damage by Occupancy (100-Year Probabilistic Event)



As the figure shows, most building damage was found to be in residential structures. Figure 3.15-52 provides the details of these findings by occupancy type; Figure 3.15-53 provides the details by building type.

Figure 3.15-52: VDEM Region 7 Hurricane Scenario – Expected Building Damage by Occupancy Details (100-Year Probabilistic Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1,737	99.79	4	0.21	0	0.00	0	0.00	0	0.00
Commercial	35,624	99.72	101	0.28	0	0.00	0	0.00	0	0.00
Education	1,929	99.69	6	0.31	0	0.00	0	0.00	0	0.00
Government	1,224	99.67	4	0.33	0	0.00	0	0.00	0	0.00
Industrial	8,580	99.69	27	0.31	0	0.00	0	0.00	0	0.00
Religion	3,715	99.78	8	0.22	0	0.00	0	0.00	0	0.00
Residential	653,102	99.92	489	0.07	10	0.00	0	0.00	0	0.00
Total	705,920		639		10		0		0	

Figure 3.25-53: VDEM Region 7 Hurricane Scenario – Expected Building Damage by Type (100-Year Probabilistic Event)

Building	None		Minor		Moderate		Severe		Destruction	
Type	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	5,710	99.58	24	0.42	0	0.00	0	0.00	0	0.00
Masonry	177,544	99.76	415	0.23	9	0.01	0	0.00	0	0.00
MH	6,463	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	23,530	99.66	81	0.34	0	0.00	0	0.00	0	0.00
Wood	492,427	99.98	79	0.02	0	0.00	0	0.00	0	0.00

Essential Facility Damage

HAZUS-MH estimated that the region has 2,857 hospital beds for use before the hurricane. On the day of the event, HAZUS-MH estimated that 2,857 beds would be available for use by patients already in the hospital and those injured by the hurricane. After seven days, 100 percent of the beds would be in service. Figure 3.15-54 shows the expected damages to all critical facilities in the region.

Figure 3.15-54: VDEM Region 7 Hurricane Scenario – Expected Damage to Essential Facilities (100-Year Probabilistic Event)

		# Facilities		
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	1	0	0	1
Fire Stations	72	0	0	72
Hospitals	17	0	0	17
Police Stations	42	0	0	42
Schools	670	0	0	670

Debris Generated

As part of the model, HAZUS-MH estimated the amount of debris that would be generated by the event. The types of debris considered were brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. HAZUS-MH estimated that a total of 23,340 tons of debris would be generated by the event. Of that amount, 58 percent would be other tree debris, seven and one half percent would be brick/wood, and 34.44 percent eligible tree debris. Assuming a load of 25 tons per truck, this would equate to 70 truckloads of debris from this scenario.

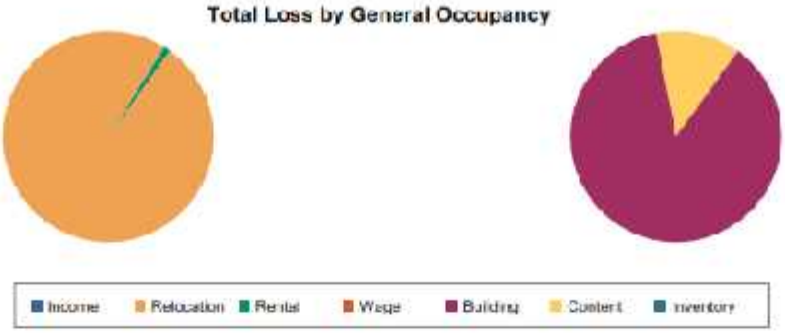
Social Impacts

HAZUS-MH estimated the number of households and people that would be expected to be displaced as a result of the scenario event. The model estimated that no households would be displaced, and that no people would be expected to seek temporary shelter in public shelters.

Economic Losses

Finally, HAZUS-MH estimated economic losses for the scenario event. HAZUS-MH estimated losses at $95.1 million, which represents approximately one quarter percent of the total replacement value of the region's buildings. One percent of the losses were related to business interruption in the scenario region. 97 percent of the losses were sustained by residential structures. Figure 3.15-55 provides additional details of these estimated losses.

Figure 3.15-55: VDEM Region 7 Hurricane Scenario – Economic Loss (100-Year Probabilistic Event)



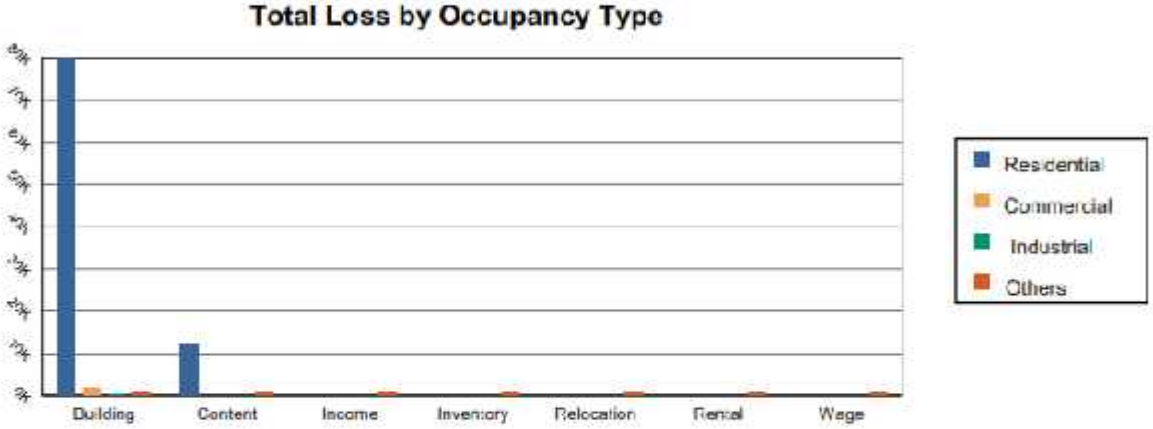


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	79,665.12	1,971.33	226.33	554.36	82,617.74
	Content	2,445.92	0.00	0.00	0.00	12,445.92
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**92,111.03**	**1,971.33**	**226.33**	**554.36**	**95,063.66**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	38.04	0.09	0.00	0.00	38.13
	Rental	0.39	0.00	0.00	0.00	0.39
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**38.43**	**0.09**	**0.00**	**0.00**	**38.52**
Total						
	Total	**92,149.47**	**1,972.02**	**226.33**	**554.36**	**95,102.18**

A 500-year and 1000-year return period scenario was also completed for each VDEM region. The differences between the 500-year and 1000-year return periods and the 100-year return period were largely increased building damages, debris, and economic losses,

as one would expect with a high return period hurricane event. For complete details of all three HAZUS-MH scenario models and results, please see the appendix.

State Facility Risk

Table 3.15-3 shows the non-rotational wind risk to state facilities from the 2013 plan.

Hurricane Risk	Number of State Facilities		Building Value at Risk*	
	Count in Risk	Cumulative Count	Value in Risk Zone	Cumulative Value
High	313	313	$209,600,771	$209,600,771
Medium-High	3,264	3.577	$5,346,635,740	$5,556,236,511
Medium-Low	7,204	10,781	$14,529,961,903	$20,086,198,414
Low	2,212	12,993	$2,543,170,461	$22,629,368,875
Total	**12,993**		**$22,629,368,875**	

**Building value for all facilities not available*
Building values at risk is based on what was available from VAPS.

For this plan update and HAZUS-MH scenario, hurricane-related losses to state facilities were not calculated; improved infrastructure and building data would lead to better analysis techniques in the future, and would allow for an increased HAZUS-MH analysis (to Level 2 or 3).

Critical Facility Risk

Detailed information about the critical facilities was not available for this revision of the plan as discussed in section 3.4. With more site-specific information (i.e., construction material, valuation, etc.), analysis could be completed to show the risk and annualized loss to the actual structure and function of the critical facilities, including through an increased HAZUS-MH analysis (to Level 2 or 3).

Hurricane Risk to Energy Pipelines

Strong wind associated with hurricanes can affect pipelines by damaging the infrastructure that supports pipeline operations such as power and telephone and satellite communications. Some pipelines require above ground facilities for their operations, like pump stations. Wind can damage these facilities, causing pipelines to be shutdown. In addition, severe wind events can make pipeline operation sites inaccessible, making it more difficult to fix the damaged equipment and restore operations. In some cases, pipeline operators may proactively shutdown pipeline operations prior to the onset of severe weather, to mitigate potential damages; this may cause supply interruptions. Flooding associated with hurricanes can also negatively impact pipeline infrastructure (See Section 3.10).

Future Conditions Considerations

Future climate model projections suggest that topical Atlantic sea surface temperatures (SSTs) will warm dramatically during the 21st century, and that upper tropospheric temperatures will warm even more than SSTs. The models also project increasing levels of vertical wind shear over parts of the western topical Atlantic. Both the increased warming of the upper tropospheric temperatures relative to the surface and increased vertical wind shear are detrimental factors for hurricane development and intensification[5].

Jurisdictional Risk

Probabilistic results represent a range of probable losses estimated from a simulation of expected hurricane activity. The results are based solely on the total direct losses for the entire study region. This ensures that all the results for a given period come from the same simulated event. Annualized losses are simply the total losses summed over the entire simulation period divided by the return period of the scenario.

Annualized losses are very useful for comparing loss estimates from different locations or comparing the risks posed by different hazards at a single location.

The Commonwealth can expect **$199,460,000** in total annualized damages estimated in HAZUS-MH v.3.2. The coastal jurisdictions of VDEM Region 5 can expect $18.4 million in annualized damages. Damages range dramatically by jurisdiction. Communities in Southwest Virginia can expect less than $80,000 in annualized damages due to hurricane winds; Northern Virginia can expect $8.5 million in annualized damages. Table 3.15-3 shows the annualized loss results by VDEM region and jurisdiction.

Table 3.15-3: HAZUS-MH Hurricane Wind Annualized Loss, by VDEM Region and Jurisdiction

VDEM Region	Jurisdiction	Annualized Hurricane Wind Annualized Loss Estimate
VDEM Region 1	Amelia	$11,883
	Brunswick	$15,535
	Charles City	$7,365
	Chesterfield	$401,677
	Colonial Heights	$24,506
	Dinwiddie	$27,895
	Emporia	$7,241
	Essex	$13,529
	Goochland	$31,649
	Greensville	$8,733
	Hanover	$146,298
	Henrico	$408,926
	Hopewell	$24,611
	King and Queen	$6,501

VDEM Region	Jurisdiction	Annualized Hurricane Wind Annualized Loss Estimate
	King William	$18,852
	New Kent	$23,599
	Nottoway	$14,987
	Petersburg	$43,551
	Powhatan	$32,780
	Prince George	$35,137
	Richmond	$270,438
	Sussex	$9,761
VDEM Region 2	Caroline	$32,472
	Clarke	$22,066
	Culpeper	$55,302
	Fauquier	$104,412
	Frederick	$90,546
	Fredericksburg	$36,211
	Greene	$18,831
	King George	$29,955
	Louisa	$41,756
	Madison	$16,206
	Orange	$40,567
	Page	$25,329
	Rappahannock	$11,777
	Shenandoah	$62,131
	Spotsylvania	$153,562
	Warren	$48,056
	Winchester	$38,485
VDEM Region 3	Albemarle	$134,637
	Amherst	$32,294
	Appomattox	$15,020
	Augusta	$77,929
	Buckingham	$11,954
	Campbell	$55,277
	Charlotte	$11,451
	Charlottesville	$55,277
	Cumberland	$9,801
	Fluvanna	$29,763
	Halifax	$35,533
	Harrisonburg	$51,506
	Lunenburg	$10,005
	Lynchburg	$91,622
	Mecklenburg	$34,893

VDEM Region	Jurisdiction	Annualized Hurricane Wind Annualized Loss Estimate
	Nelson	$22,694
	Prince Edward	$20,140
	Rockingham	$81,727
	Staunton	$30,691
	Waynesboro	$26,145
VDEM Region 4	Bland	$6,244
	Bristol	$20,997
	Buchanan	$18,027
	Carroll	$28,509
	Dickenson	$11,150
	Galax	$9,266
	Grayson	$15,121
	Lee	$19,871
	Norton	$5,441
	Pulaski	$37,154
	Radford	$16,136
	Russell	$21,306
	Scott	$20,747
	Smyth	$29,485
	Tazewell	$39,622
	Washington	$58,014
	Wise	$32,629
	Wythe	$29,362
VDEM Region 5	Accomack	$42,064
	Chesapeake	$266,902
	Franklin	$9,114
	Gloucester	$44,283
	Hampton	$153,221
	Isle of Wight	$43,804
	James City	$100,341
	Lancaster	$19,286
	Mathews	$11,630
	Middlesex	$16,838
	Newport News	$207,121
	Norfolk	$291,729
	Northampton	$15,795
	Northumberland	$21,873
	Poquoson	$16,834
	Portsmouth	$102,661
	Richmond	$9,091

VDEM Region	Jurisdiction	Annualized Hurricane Wind Annualized Loss Estimate
	Southampton	$17,957
	Suffolk	$96,625
	Surry	$7,562
	Virginia Beach	$550,430
	Westmoreland	$26,146
	Williamsburg	$19,283
	York	$92,172
VDEM Region 6	Alleghany	$18,400
	Bath	$8,585
	Bedford	$84,917
	Botetourt	$42,432
	Buena Vista	$7,352
	Covington	$7,004
	Craig	$5,686
	Danville	$52,295
	Floyd	$14,322
	Franklin	$68,227
	Henry	$55,385
	Highland	$3,836
	Lexington	$9,729
	Martinsville	$19,976
	Montgomery	$99,293
	Patrick	$17,904
	Pittsylvania	$57,090
	Roanoke	$235,962
	Rockbridge	$26,044
	Salem	$35,288
VDEM Region 7	Alexandria	$231,504
	Arlington	$319,523
	Fairfax	$1,617,701
	Falls Church	$22,190
	Loudoun	$444,365
	Manassas	$48,240
	Manassas Park	$15,328
	Prince William	$505,334
	Stafford	$167,164

Annualized damages were also calculated based on NCEI crop and property damages; the Commonwealth can expect approximately **$25,630,543** in damages per year from non-rotational wind events. NCEI annualized damages have been calculated by taking the total damages per

jurisdiction and dividing by the period of record. Multiple factors account for the differences in the two annualized loss values. While NCEI's data is based on *reported* estimates, the HAZUS-MH results are based on a highly developed model using census tract data and estimates of hurricane winds to come up with potential damage. HAZUS-MH total direct economic loss includes damage to structural, non-structural, building contents, inventory loss, relocation, income loss, rental loss and wage loss.

Table 3.15-4 shows the hazard rank for non-rotational winds (primarily hurricane and tropical weather patterns, although thunderstorm winds are also included). Relative to the rest of Virginia, the eastern jurisdictions have the highest risk for non-rotational wind. This ranking, based on NCEI records, does not distinguish winds resulting from tropical and non-tropical weather systems. In addition, some of the impacts in the NCEI records may have been coded as hurricane (and included in this wind section), but may be more directly related to secondary impacts of hurricanes (such as flooding). However, sorting these damages out would be very difficult given the available information.

Table 3.15-4: Non-Rotational Wind Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	High	High	Medium-Low	Low	Medium
Albemarle	Medium-High	Medium	Low	High	Medium	High	Medium-Low	Medium
Alexandria, City of	Medium-High	High	High	High	Low	Medium-Low	Medium-Low	Medium
Alleghany	Low	Low	Low	Medium-High	Low	Medium	Low	Medium-Low
Amelia	Low	Low	Medium-Low	High	Low	Medium-Low	Low	Medium-Low
Amherst	Medium	Medium	Low	Medium-High	Low	Medium-High	Low	Medium-Low
Appomattox	Low	Low	Low	Medium	Low	Medium-Low	High	Medium-Low
Arlington	High	High	Low	High	Medium	Medium-Low	Medium	Medium
Augusta	Medium-High	Medium	Low	High	Medium-High	Medium-High	Low	Medium
Bath	Low	Low	Low	Medium	Low	Medium-Low	Low	Low
Bedford	Medium-High	Medium	Low	High	Low	High	High	Medium
Bland	Low	Low	Low	Medium-High	Low	Low	Low	Low
Botetourt	Medium	Medium	Low	Low	Low	Medium-Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Bristol, City of	Low	Medium-High	High	High	Low	Medium	Low	Medium
Brunswick	Medium	Low	Medium-Low	High	Low	Low	Low	Medium-Low
Buchanan	Medium	Low	Medium-High	Medium-Low	High	Medium	Low	Medium
Buckingham	Low	Low	Low	Medium	Low	Medium-Low	Low	Low
Buena Vista, City of	Low	Medium-High	Low	High	Low	Medium-High	Low	Medium-Low
Campbell	Medium	Medium	High	Medium-Low	Low	Low	Low	Medium-Low
Caroline	Medium	Low	Low	High	Low	High	Low	Medium-Low
Carroll	Medium	Medium	Low	Medium	Low	Medium	Low	Medium-Low
Charles City	Low	Low	Low	High	Low	Medium	Low	Medium-Low
Charlotte	Low	Low	Low	Low	Medium	Low	Low	Low
Charlottesville, City of	Medium	High	Low	High	Medium	Medium-High	Low	Medium
Chesapeake, City of	High	Medium-High	Low	High	Medium	Medium-Low	Medium	Medium
Chesterfield	High	Medium-High	Low	High	High	Medium	Medium	Medium-High

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Clarke	Low	Medium	Low	High	Low	Medium-High	Low	Medium-Low
Colonial Heights, City of	Medium	High	High	Medium	Low	Medium-High	Low	Medium
Covington, City of	Low	Medium-High	Medium-Low	High	Low	Low	Low	Medium-Low
Craig	Low	Low	High	Medium	Low	Medium-Low	Low	Medium-Low
Culpeper	Medium	Medium	High	Medium	Medium-Low	Medium-Low	Low	Medium
Cumberland	Low	Low	Low	High	Medium	Medium-High	Low	Medium-Low
Danville, City of	Medium	Medium-High	Low	Medium	Medium-Low	Medium-Low	Low	Medium-Low
Dickenson	Low	Low	Low	High	Medium	Medium-Low	Low	Medium-Low
Dinwiddie	Medium	Low	Low	Medium-Low	Low	Low	Low	Low
Emporia	Low	Medium-High	Low	High	High	Medium-Low	Low	Medium
Essex	Low	Low	Low	Medium	Low	Low	Low	Low
Fairfax	High	High	Low	High	Medium	Medium-Low	Medium	Medium
Fairfax, City of	Medium	High	Low	High	Low	High	High	Medium
Falls Church, City of	Low	High	Medium-Low	High	Low	Medium-Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Fauquier	Medium-High	Medium	Low	High	Low	Medium-Low	Medium-Low	Medium
Floyd	Low	Low	Low	High	Low	High	Low	Medium-Low
Fluvanna	Medium	Medium	Low	Medium	Low	Medium-Low	Low	Medium-Low
Franklin	Medium	Medium	Medium-Low	Medium	Low	Medium-Low	Low	Medium-Low
Franklin, City of	Low	Medium-High	Medium-Low	High	Low	High	Low	Medium
Frederick	Medium-High	Medium	Low	Low	High	Low	Low	Medium-Low
Fredericksburg, City of	Medium	High	Low	High	High	Medium-High	Low	Medium
Galax, City of	Low	Medium-High	Low	High	Medium	Low	Low	Medium-Low
Giles	Low	Low	High	Medium	Low	Medium-Low	Low	Medium-Low
Gloucester	Medium	Medium	Medium-Low	Medium-High	Low	Medium	Low	Medium-Low
Goochland	Medium	Medium	Low	High	High	Medium-Low	Low	Medium
Grayson	Low	Low	Medium-Low	Low	Low	Medium-Low	Low	Low
Greene	Medium	Medium	Medium-Low	Medium	Low	Medium	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Greensville	Low	Low	High	Medium	Medium-Low	Medium-Low	Low	Medium-Low
Halifax	Medium	Low	Low	Medium-Low	Low	Medium-Low	Low	Low
Hampton, City of	Medium-High	High	Medium-Low	High	Low	High	Medium-Low	Medium
Hanover	Medium-High	Medium	Low	High	Medium	Medium-Low	Medium-Low	Medium
Harrisonburg, City of	Medium	High	Medium-Low	Medium-High	Medium-Low	Medium	Low	Medium
Henrico	High	Medium-High	Low	Medium-High	Medium-Low	Low	Medium	Medium
Henry	Medium	Medium	Low	High	Medium-Low	High	Low	Medium
Highland	Low	Low	High	High	Medium-Low	High	Medium	Medium
Hopewell, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Isle of Wight	Medium	Medium	Low	High	High	Low	Low	Medium
James City	Medium-High	Medium-High	Low	High	High	Medium-Low	Medium-Low	Medium
King and Queen	Low	Low	Low	High	Low	Medium-Low	Low	Medium-Low
King George	Medium	Medium	Low	Low	High	Medium-Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
King William	Low	Low	Medium-Low	High	Low	Medium	Low	Medium-Low
Lancaster	Low	Medium	Medium-Low	Low	Medium-High	Medium-Low	Low	Medium-Low
Lee	Medium	Low	Low	High	Medium	Medium-Low	Low	Medium-Low
Lexington, City of	Low	High	Low	Medium	Medium-Low	Medium	Low	Medium-Low
Loudoun	High	Medium-High	Medium-Low	Medium	Low	Low	Medium	Medium
Louisa	Medium	Medium	Medium-Low	High	Medium-Low	High	Low	Medium
Lunenburg	Low	Low	Low	Medium-High	Low	Medium	Low	Medium-Low
Lynchburg, City of	Low	Medium-High	Low	Medium	Medium-Low	Medium-Low	Low	Medium-Low
Madison	Low	Low	Low	High	Low	Medium-Low	Low	Medium-Low
Manassas, City of	Medium	High	Medium-Low	Medium	Medium	Medium	Low	Medium
Manassas Park, City of	Low	High	High	High	Low	Medium-Low	Low	Medium
Martinsville, City of	Low	Medium-High	Low	High	Low	Low	Low	Medium-Low
Mathews	Low	Medium	Low	High	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Mecklenburg	Medium	Low	Low	High	Medium-High	Low	Low	Medium-Low
Middlesex	Low	Medium	Low	High	High	Medium	Low	Medium
Montgomery	Medium-High	Medium	Low	High	High	Medium-Low	Low	Medium
Nelson	Low	Low	Medium-Low	High	Medium-Low	Medium-High	Low	Medium-Low
New Kent	Low	Medium	Medium-Low	Medium-Low	Medium-Low	Medium	Low	Medium-Low
Newport News, City of	High	High	Low	Medium-Low	Low	Medium-Low	Medium-Low	Medium
Norfolk, City of	High	High	Low	High	Medium	Medium-Low	Medium	Medium
Northampton	Low	Medium	Low	High	Low	Medium-Low	Low	Medium-Low
Northumberland	Low	Low	Low	High	High	Medium-Low	Low	Medium-Low
Norton	Low	Medium-High	Low	High	Medium-High	Medium-Low	Low	Medium
Nottoway	Low	Low	Medium-Low	Low	Low	Low	Low	Medium-Low
Orange	Medium	Medium	Medium-Low	Low	Low	Medium	Low	Medium-Low
Page	Medium	Medium	Low	High	Medium-High	Medium-High	Low	Medium
Patrick	Medium	Low	Low	High	High	Medium	Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Petersburg, City of	Medium	Medium-High	Low	High	Low	Medium-High	Low	Medium
Pittsylvania	Medium-High	Medium	Low	High	High	Low	Low	Medium
Poquoson	Low	Medium-High	Low	High	Medium-High	High	Low	Medium
Portsmouth, City of	Medium-High	High	Low	High	Low	Low	Medium-Low	Medium
Powhatan	Medium	Medium	Medium-Low	High	Low	Medium-Low	Low	Medium-Low
Prince Edward	Medium	Medium	Low	High	Medium-Low	Medium-Low	Low	Medium-Low
Prince George	Medium	Medium	Low	Medium-Low	Low	Medium	Low	Medium-Low
Prince William	High	Medium-High	Low	High	High	Medium	Medium-High	Medium-High
Pulaski	Medium	Medium	Low	High	Low	High	Low	Medium
Radford, City of	Low	Medium-High	Low	Medium-High	Low	Medium	Low	Medium-Low
Rappahannock	Low	Low	Low	Low	Low	Low	Low	Low
Richmond	Low	Low	Low	Medium-Low	Medium	Medium-Low	Low	Low
Richmond, City of	High	High	Medium-Low	Medium-Low	Medium	Medium-Low	Medium	Medium
Roanoke	Medium-High	Medium-High	High	High	Medium-Low	Medium-Low	Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Roanoke, City of	Medium-High	High	Low	High	Low	Medium-High	Medium-Low	Medium
Rockbridge	Medium	Low	Low	High	Low	Medium-Low	Low	Medium-Low
Rockingham	Medium-High	Medium	Low	High	Low	Medium-High	Low	Medium
Russell	Medium	Low	Low	High	Medium	Medium-High	Low	Medium
Salem, City of	Medium	High	Low	Medium-High	Low	Medium	Low	Medium
Scott	Medium	Low	Medium	Medium-High	Low	Medium-Low	Low	Medium-Low
Shenandoah	Medium	Medium	High	Medium-High	Medium-Low	Medium	Low	Medium
Smyth	Medium	Medium	Medium-Low	Medium-High	High	Medium-High	Low	Medium
Southampton	Low	Low	Medium	Medium	Low	Medium	Low	Medium-Low
Spotsylvania	Medium-High	Medium	Low	Medium-Low	High	Medium-Low	Medium-Low	Medium
Stafford	Medium-High	Medium-High	Low	High	Medium	High	Medium-Low	Medium
Staunton, City of	Medium	Medium-High	Medium-Low	High	Low	Medium-High	Low	Medium
Suffolk	Medium-High	Medium	Low	Medium-High	Medium-High	Low	Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Surry	Low	Low	Low	High	High	Medium	Low	Medium-Low
Sussex	Low	Low	Medium-Low	High	High	Medium-Low	Low	Medium-Low
Tazewell	Medium	Medium	Medium-Low	Medium-Low	Medium-High	Medium-Low	Low	Medium-Low
Virginia Beach, City of	High	High	Low	High	Low	Medium	Medium-High	Medium
Warren	Medium	Medium	Low	High	High	Medium-High	Low	Medium
Washington	Medium	Medium	Low	Medium	Medium	Medium	Low	Medium-Low
Waynesboro, City of	Medium	Medium-High	Low	High	Medium-Low	Medium-High	Low	Medium
Westmoreland	Low	Medium	Low	High	Medium-High	Low	Low	Medium-Low
Williamsburg, City of	Low	Medium-High	Low	Medium	Medium	Medium-Low	Low	Medium-Low
Winchester, City of	Medium	High	Low	High	Low	Low	Low	Medium-Low
Wise	Medium	Medium	Low	Medium-High	High	Medium-Low	Low	Medium
Wythe	Medium	Medium	Low	Medium-High	Low	Medium	Low	Medium-Low
York	Medium-High	Medium-High	Low	Medium	Low	Medium	Low	Medium-Low

For the 2018 plan, the overall hazard ranking for non-rotation wind is medium.

Local Plan Risk Assessment

Each of the 20 local plans were reviewed and summarized based on methodology and results for their non-rotational wind analysis. Each plan varied based on the type of data available and analysis methodology. Techniques for assessing wind risk in the local plans included one or more of the following methods:

- FEMA HAZUS-MH
- NCEI statistics
- FEMA Wind Benefit-Coast Module to determine percent of buildings constructed before and after adoption of local building codes
- ASCE Wind Design Speeds
- Referenced Virginia Hurricane Evacuation Study

Of the 20 local plans, 11 plans utilized HAZUS-MH for hurricane wind analysis in some fashion. Nine plans did not calculate annualized loss for hurricane.

As discussed in section 3.6 and previously, local plan hazard analysis and loss estimations vary considerably. The definition of what is considered a wind hazard also varies and should be evaluated for consistencies in future plans. Table 3.15-5 and Figure 3.6-2 (section 3.6) shows the summary of the local plans that provided annualized losses. None of the annualized loss values for the local plan are the same as the values calculated for this revision. The difference can result from different types of HAZUS-MH scenarios completed and study area selected for the model run.

Table 3.15-5: Local Annualized Loss Estimates

Local Plan	Annualized Loss
Commonwealth RC	$279,714
Central Shenandoah PDC	$274,179
Hampton Roads	$86,748,000
Middle Peninsula	$2,228,660
New River Valley	$563,000
Northern Virginia	$6,898,000
Rappahannock Rapidan	$139,000
Richmond Crater	$4,400,000
Southside	$482,000
Thomas Jefferson	$385,000
West Piedmont	$893,967

Comparison with Local Ranking

Six of the 20 regional and local hazard mitigation plans ranked hurricane related winds as a high hazard, two were ranked as moderate, and one was ranked low. Four regional and local hazard mitigation plans ranked wind as high, four were ranked moderate-high, two were ranked as moderate, and one was ranked low. The regional plan average for hurricane wind is high. The 2018 statewide analysis has ranked non-rotational wind as a medium hazard. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

The majority of local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). Some of the coastal communities discussed development of residential structures in high hazard areas and the need to evaluate engineering practices before development or elevation occurs.

Table 3.15-6: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impact expected to be severe to extensive for event areas and minor for other adversely affected areas.
Health and Safety of Response Personnel	Localized impacts expected to be minor unless the response personnel live within the impacted area.
Continuity of Operations	Damage to facilities/personnel in the area of the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure in the area of the event could be extensive.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be moderate, including uprooted trees and widespread debris, which may include HAZMAT.
Economic and Financial Condition	Local economy and finances adversely impacted, possibly for a prolonged period of time.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient.

Endnotes

[1] National Hurricane Center. Saffir-Simpson Hurricane Wind Scale. Verified 05.03.17 from http://www.nhc.noaa.gov/aboutsshs.shtml

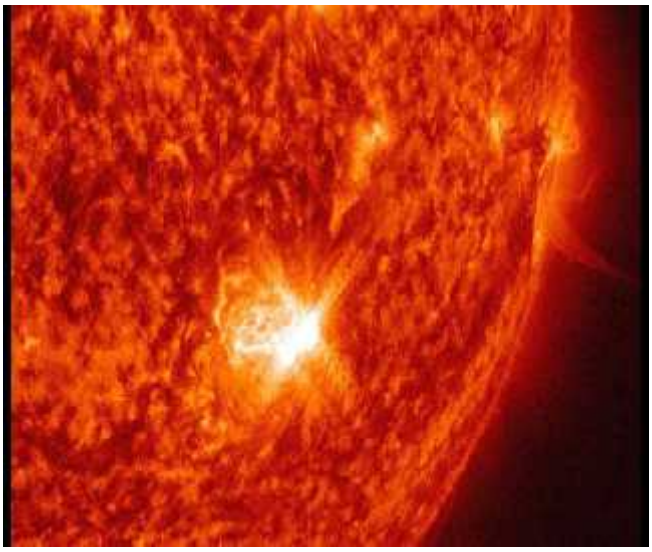
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[5] NOAA: Geophysical Fluid Dynamics Laboratory. Global Warming and Hurricanes. Retrieved May 11, 2017 from, https://www.gfdl.noaa.gov/global-warming-and-hurricanes/

Section 3.16: Solar Storm

Description

Space weather is the term used to describe conditions in space that affect the Earth and its technological systems. Storms in space originate from the sun and occur in Near-Earth space or in the Earth's atmosphere. These storms generally occur due to eruptions on the sun known as solar flares and coronal mass ejections (CMEs). Rather than the on-Earth weather contributors of water, temperature, and air, solar storms are a result of changes in the continuous flow of solar particles and magnetic fields from the sun, known as solar wind[1].

NOAA's Space Weather Prediction Center (SWPC) forecasts space weather to assist users in avoiding or mitigating severe solar storms. The SWPC provides real-time monitoring and forecasting of solar events, and issues watches, warnings, and alerts for hazardous weather events.
Technology on Earth can be vulnerable to hazardous space weather – in particular, to the effects of solar storms. With dependence on technology increasing, vulnerability to hazardous space weather has increased significantly.



Solar Flare
Source: NASA

Solar storms are organized into three categories: geomagnetic storms, solar radiation storms, and radio blackouts.

Geomagnetic storms bring electrical currents that can have significant impacts on electrical transmission equipment. Geomagnetic storms can result in widespread electrical failures, though most electric power companies have procedures in place to mitigate the impacts of these storms. Geomagnetic storms can also interrupt precision GPS, including navigational systems, such as those used by the Federal Aviation Administration. These storms can also affect satellites, such as those used for radio and television transmissions, military surveillance, credit card transmission, and cell phone transmissions.

Solar radiation storms are of concern for operators and passengers of aircraft, particularly for those flying routes near the Earth's poles. NASA is also concerned about solar radiation storms, and must take efforts to shield the International Space Station (and its crew) from this increase in radiation.

Radio blackouts affect high frequency (HF) communications, which can significantly impact sectors that rely on HF communications for operations, namely airlines that rely on HF for communications while taking polar routes. Emergency response teams that rely on HF communications can also be impacted during these blackouts[2].

Historic Occurrence

Perhaps the most well-known occurrence of a solar storm occurred on September 1, 1859. Known as the Carrington Event, this massive solar storm was first detected by amateur astronomer Richard Carrington. He described his observation as 'two patches of intensely bright and white light,' erupting from the spots on the sun. Within minutes, the fireballs vanished.

Within hours, however, the impact of those spots was felt around the Earth. Later that night, telegraph communications began to fail around the globe. There were reports of sparks from telegraph machines; these sparks shocked operators and set paper on fire. Colorful auroras illuminated the night sky around the Earth; these auroras were so bright that there were reports of birds singing and chirping (as though it were day) and laborers rising for the day, believing the sun had risen.

With his naked eye, Richard Carrington had seen the cause of this unusual activity – a massive solar flare with the energy of 10B atomic bombs. This event, and the resulting geomagnetic storm, is the largest to have struck the Earth. Ice core samples have confirmed that the Carrington Event was twice as large as any other solar storm in the previous 500 years[3].

As our technology and ability to study space has increased, so has our ability to determine occurrences of the solar storm hazard. Thought it may appear that these events are occurring more frequently than in the past, it is likely that we can now better detect the events when they do happen and we have more technology to be disrupted by them.

There are no recorded instances of solar storm impacts in the Commonwealth of Virginia, and none were reported during the update of this plan.

Risk Assessment

Probability

The probability of solar storms cannot be expressed in terms of specific return periods or recurrence intervals as it can be with other hazards. Currently, NASA is unable to predict these events; they can only monitor and provide some warning of storms before they impact Earth. While there are some who claim they have developed models to provide a probability of a storm occurring in a given timeframe, these claims have not been embraced or endorsed by NASA at this time.

Given the rarity of events that impact Earth (the Carrington event being more than 150 years in the past), this hazard has an assigned probability of low.

Impact and Vulnerability

Solar storms can impact the Commonwealth of Virginia through the disruption of both electrical power transmission and HF radio communications.

The electric power grid, and consequently the power distribution to the around the Commonwealth, could be disrupted by solar storms.

Depending on the transformer design, solar storms can lead to heating of the surrounding structures due to induced 'Eddy Currents' which has the potential to damage parts of the transformer. An additional impact of transformer saturation is that the voltages and currents no longer have a simple sinusoidal (60 cycle) form and this can cause protective equipment elsewhere in the grid to trip when it should not. These equipment 'trips' can take needed equipment off line and cause voltage stability problems. An additional issue for the system is that all the transformers that are saturating show up as a significant inductive load on the grid. This means that a system that is near peak levels of demand prior to the geomagnetic storm event may not be able to meet the total power demand when the geomagnetic storm occurs, leading to partial or system wide blackouts[4].

High frequency radio communications may also be disrupted by solar storms or other space weather. At frequencies in the 1 to 30 mega Hertz range (known as 'High Frequency' or HF radio), the changes in ionospheric density and structure modify the transmission path and even block transmission of HF radio signals completely. These frequencies are used by amateur (ham) radio operators and many industries such as commercial airlines. They are also used by several government agencies such as FEMA and the Department of Defense (DOD).

There are several types of space weather that can impact HF radio communication. In a typical sequence of space weather storms, the first impacts are felt during the solar flare itself. The solar

x-rays from the sun penetrate to the bottom of the ionosphere (to around 80 km). There the x-ray photons ionize the atmosphere and create an enhancement of the D layer of the ionosphere. This enhanced D-layer acts both as a reflector of radio waves at some frequencies and an absorber of waves at other frequencies. The Radio Blackout associated with solar flares occurs on the dayside region of Earth and is most intense when the sun is directly overhead.

Another type of space weather, the Radiation Storm caused by energetic solar protons, can also disrupt HF radio communication. The protons are guided by Earth's magnetic field such that they collide with the upper atmosphere near the north and south poles. The fast-moving protons have an affect like the x-ray photons and create an enhanced D-Layer thus blocking HF radio communication at high latitudes. During auroral displays, the precipitating electrons can enhance other layers of the ionosphere and have similar disrupting and blocking effects on radio communication. This occurs mostly on the night side of the polar regions of Earth where the aurora is most intense and most frequent[5].

Technology on Earth can be vulnerable to hazardous space weather – in particular, to the effects of solar storms. With dependence on technology increasing, vulnerability to hazardous space weather has increased significantly.

Risk

Data on the total financial impact of these events is not complete. Risk, strictly defined as probability multiplied by impact, cannot be fully estimated for solar storm due to the lack of accepted intensity-damage models for solar storm events. Therefore, projected annualized dollar losses cannot be estimated.

State Facility Risk

To determine which facilities are at risk for solar storms, each state facility in Virginia was reviewed. A total of 12,804 facilities have been identified as being state-owned. The review determined that each state-owned facility in the commonwealth had at least some risk from solar storms, as each facility has some form of electrical wiring that supports the building and most have some form of communication equipment (i.e., telephones, cell towers, radio stations, etc.). While the facilities themselves are not at risk from solar storms, some of the systems that support them – namely electrical and communications – may be at risk during a solar event.

Annualized loss estimates were not calculated for state facilities due to the lack of building detail data available (including valuation and specific electrical components and systems), and the lack of probabilities of future occurrences.

Critical Facility Risk

Risk for critical facilities was calculated in the same fashion described for state facilities. The results of this analysis indicate that 2,420 of critical facilities (or the electrical/communications systems that they rely on) are at risk from solar storms. Annualized loss estimates were not calculated for critical facilities due to the limited information on mapped critical facilities (including valuation data and specifics of electrical and communications equipment), and the lack of probabilities of future occurrences. Table 3-16.1 details these critical facilities by use and agency.

Table 3.16-2: Critical Facilities at Risk from Solar Storms

Critical Facility Use	Number at Risk from Solar Storms
Airfield	12
Animal Health	27
Armory	39
Childcare	10
Communications	76
Emergency Operations Center	1
Fire Service/Support/Suppression	35
Food Service/Storage	88
Fuel Storage/Delivery	516
Hazardous Materials Storage	433
Medical Services/Support/EMS	128
Public Safety/Security	200
Research	178
Special Populations Housing / Shelter	27
Utilities	650
Total:	**2,420**

Solar Storm Risk to Energy Pipelines

Solar storms can affect pipelines by damaging the infrastructure that supports pipeline operations such as power and telephone and satellite communications. In some cases, pipeline operators may proactively shutdown pipeline operations prior to the onset of severe weather, to mitigate potential damages; this may cause supply interruptions.

Future Conditions Considerations

Most climate scientists agree that solar storms could play a role in climate change on Earth, but the clear majority view that role as minimal at best. They attribute changing climate conditions on Earth to more terrestrial forces, rather than those originating in space or with the sun[6].

Jurisdictional Risk

To compare different hazards based on a common system, inputs for solar storms were very limited because of no recorded NCEI events. To be able to include land subsidence in the risk assessment some general assumptions were made. For each category (except population), a ranking of Low was assigned. This was based on the lack of history and the inability to determine a probability of a future occurrence.

Local Plan Risk Assessment

Currently, no local plans address solar storms. However, it is anticipated that solar storms may be included in future updates.

Comparison with Local Ranking

Currently, no local plans address solar storms. However, it is anticipated that solar storms may be included in future updates.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2).

Table 3.16-2: Solar Storm Hazard Parameter Rankings

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Low	Medium	Low	Low	Low	Low	Low	Low
Albemarle	Low	Medium	Low	Low	Low	Low	Low	Low
Alexandria, City of	Low	High	Low	Low	Low	Low	Low	Low
Alleghany	Low	Low	Low	Low	Low	Low	Low	Low
Amelia	Low	Low	Low	Low	Low	Low	Low	Low
Amherst	Low	Medium	Low	Low	Low	Low	Low	Low
Appomattox	Low	Low	Low	Low	Low	Low	Low	Low
Arlington	Low	High	Low	Low	Low	Low	Low	Low
Augusta	Low	Medium	Low	Low	Low	Low	Low	Low
Bath	Low	Low	Low	Low	Low	Low	Low	Low
Bedford	Low	Medium	Low	Low	Low	Low	Low	Low
Bland	Low	Low	Low	Low	Low	Low	Low	Low
Botetourt	Low	Medium	Low	Low	Low	Low	Low	Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Brunswick	Low	Low	Low	Low	Low	Low	Low	Low
Buchanan	Low	Low	Low	Low	Low	Low	Low	Low
Buckingham	Low	Low	Low	Low	Low	Low	Low	Low
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Campbell	Low	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Caroline	Low	Low	Low	Low	Low	Low	Low	Low
Carroll	Low	Medium	Low	Low	Low	Low	Low	Low
Charles City	Low	Low	Low	Low	Low	Low	Low	Low
Charlotte	Low	Low	Low	Low	Low	Low	Low	Low
Charlottesville, City of	Low	High	Low	Low	Low	Low	Low	Low
Chesapeake, City of	High	Medium-High	Low	Low	Low	Low	Low	Low
Chesterfield	Low	Medium-High	Low	Low	Low	Low	Low	Low
Clarke	Low	Medium	Low	Low	Low	Low	Low	Low
Colonial Heights, City of	Low	High	Low	Low	Low	Low	Low	Low
Covington, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Craig	Low	Low	Low	Low	Low	Low	Low	Low
Culpeper	Low	Medium	Low	Low	Low	Low	Low	Low
Cumberland	Low	Low	Low	Low	Low	Low	Low	Low
Danville, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Dickenson	Low	Low	Low	Low	Low	Low	Low	Low
Dinwiddie	Low	Low	Low	Low	Low	Low	Low	Low
Emporia	Low	Medium-High	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Essex	Low	Low	Low	Low	Low	Low	Low	Low
Fairfax	Low	High	Low	Low	Low	Low	Low	Low
Fairfax, City of	Low	High	Low	Low	Low	Low	Low	Low
Falls Church, City of	Low	High	Low	Low	Low	Low	Low	Low
Fauquier	Low	Medium	Low	Low	Low	Low	Low	Low
Floyd	Low	Low	Low	Low	Low	Low	Low	Low
Fluvanna	Low	Medium	Low	Low	Low	Low	Low	Low
Franklin	Medium	Medium	Low	Low	Low	Low	Low	Low
Franklin, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Frederick	Low	Medium	Low	Low	Low	Low	Low	Low
Fredericksburg, City of	Low	High	Low	Low	Low	Low	Low	Low
Galax, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Giles	Low	Low	Low	Low	Low	Low	Low	Low
Gloucester	Medium	Medium	Low	Low	Low	Low	Low	Low
Goochland	Low	Medium	Low	Low	Low	Low	Low	Low
Grayson	Low	Low	Low	Low	Low	Low	Low	Low
Greene	Low	Medium	Low	Low	Low	Low	Low	Low
Greensville	Low	Low	Low	Low	Low	Low	Low	Low
Halifax	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Hampton, City of	Medium-High	High	Low	Low	Low	Low	Low	Low
Hanover	Low	Medium	Low	Low	Low	Low	Low	Low
Harrisonburg, City of	Low	High	Low	Low	Low	Low	Low	Low
Henrico	Low	Medium-High	Low	Low	Low	Low	Low	Low
Henry	Low	Medium	Low	Low	Low	Low	Low	Low
Highland	Low	Low	Low	Low	Low	Low	Low	Low
Hopewell, City of	Low	High	Low	Low	Low	Low	Low	Low
Isle of Wight	Medium	Medium	Low	Low	Low	Low	Low	Low
James City	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
King and Queen	Low	Low	Low	Low	Low	Low	Low	Low
King George	Low	Medium	Low	Low	Low	Low	Low	Low
King William	Low	Low	Low	Low	Low	Low	Low	Low
Lancaster	Low	Medium	Low	Low	Low	Low	Low	Low
Lee	Low	Low	Low	Low	Low	Low	Low	Low
Lexington, City of	Low	High	Low	Low	Low	Low	Low	Low
Loudoun	Low	Medium-High	Low	Low	Low	Low	Low	Low
Louisa	Low	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Lunenburg	Low	Low	Low	Low	Low	Low	Low	Low
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Madison	Low	Low	Low	Low	Low	Low	Low	Low
Manassas, City of	Low	High	Low	Low	Low	Low	Low	Low
Manassas Park, City of	Low	High	Low	Low	Low	Low	Low	Low
Martinsville, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Mathews	Low	Medium	Low	Low	Low	Low	Low	Low
Mecklenburg	Low	Low	Low	Low	Low	Low	Low	Low
Middlesex	Low	Medium	Low	Low	Low	Low	Low	Low
Montgomery	Low	Medium	Low	Low	Low	Low	Low	Low
Nelson	Low	Low	Low	Low	Low	Low	Low	Low
New Kent	Low	Medium	Low	Low	Low	Low	Low	Low
Newport News, City of	High	High	Low	Low	Low	Low	Low	Low
Norfolk, City of	High	High	Low	Low	Low	Low	Low	Low
Northampton	Low	Medium	Low	Low	Low	Low	Low	Low
Northumberland	Low	Low	Low	Low	Low	Low	Low	Low
Norton	Low	Medium-High	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Nottoway	Low	Low	Low	Low	Low	Low	Low	Low
Orange	Low	Medium	Low	Low	Low	Low	Low	Low
Page	Low	Medium	Low	Low	Low	Low	Low	Low
Patrick	Low	Low	Low	Low	Low	Low	Low	Low
Petersburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Pittsylvania	Low	Medium	Low	Low	Low	Low	Low	Low
Poquoson	Low	Medium-High	Low	Low	Low	Low	Low	Low
Portsmouth, City of	Medium-High	High	Low	Low	Low	Low	Low	Low
Powhatan	Low	Medium	Low	Low	Low	Low	Low	Low
Prince Edward	Low	Medium	Low	Low	Low	Low	Low	Low
Prince George	Low	Medium	Low	Low	Low	Low	Low	Low
Prince William	Low	Medium-High	Low	Low	Low	Low	Low	Low
Pulaski	Low	Medium	Low	Low	Low	Low	Low	Low
Radford, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Rappahannock	Low	Low	Low	Low	Low	Low	Low	Low
Richmond	Low	Low	Low	Low	Low	Low	Low	Low
Richmond, City of	Low	High	Low	Low	Low	Low	Low	Low
Roanoke	Low	Medium-	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
		High						
Roanoke, City of	Low	High	Low	Low	Low	Low	Low	Low
Rockbridge	Low	Low	Low	Low	Low	Low	Low	Low
Rockingham	Low	Medium	Low	Low	Low	Low	Low	Low
Russell	Low	Low	Low	Low	Low	Low	Low	Low
Salem, City of	Low	High	Low	Low	Low	Low	Low	Low
Scott	Low	Low	Low	Low	Low	Low	Low	Low
Shenandoah	Low	Medium	Low	Low	Low	Low	Low	Low
Smyth	Low	Medium	Low	Low	Low	Low	Low	Low
Southampton	Low	Low	Low	Low	Low	Low	Low	Low
Spotsylvania	Low	Medium	Low	Low	Low	Low	Low	Low
Stafford	Low	Medium-High	Low	Low	Low	Low	Low	Low
Staunton, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Suffolk	Medium-High	Medium	Low	Low	Low	Low	Low	Low
Surry	Low	Low	Low	Low	Low	Low	Low	Low
Sussex	Low	Low	Low	Low	Low	Low	Low	Low
Tazewell	Low	Medium	Low	Low	Low	Low	Low	Low
Virginia Beach, City of	High	High	Low	Low	Low	Low	Low	Low
Warren	Low	Medium	Low	Low	Low	Low	Low	Low
Washington	Low	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Waynesboro, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Westmoreland	Low	Medium	Low	Low	Low	Low	Low	Low
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Winchester, City of	Low	High	Low	Low	Low	Low	Low	Low
Wise	Low	Medium	Low	Low	Low	Low	Low	Low
Wythe	Low	Medium	Low	Low	Low	Low	Low	Low
York	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low

For the 2018 plan, the overall hazard ranking is low.

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts are expected to be moderate to severe for affected areas and moderate to light for less impacted areas.
Health and Safety of Response Personnel	Personnel are expected to have communications issues.
Continuity of Operations	Unlikely to execute Continuity of Operations Plan
Property, Facilities, and Infrastructure	Electrical outages and communication issues are expected.
Delivery of Services	Localized disruption of communications caused by the event may postpone the delivery of some services.
The Environment	Electrical issues could have an increased risk of fire.
Economic and Financial Condition	Local economy may be impacted depending on type of event, local retailers may not be able to open for business.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient

Table 3.19-1 Emergency Management Accreditation Plan Analysis

Endnotes

[1] National Oceanic and Atmospheric Administration, Space Weather Prediction Center. Retrieved 04.15.17 from http://www.swpc.noaa.gov/phenomena/solar-flares-radio-blackouts
[2] National Oceanic and Atmospheric Administration, Space Weather Prediction Center. Retrieved 04.15.17 from http://www.swpc.noaa.gov/impacts
[3] History.com. *A Perfect Solar Superstorm: the 1859 Carrington Event.* Retrieved 04.15.17 from http://www.history.com/news/a-perfect-solar-superstorm-the-1859-carrington-event
[4] National Oceanic and Atmospheric Administration, Space Weather Prediction Center. Retrieved 04.15.17 from http://www.swpc.noaa.gov/impacts/electric-power-transmission
[5] National Oceanic and Atmospheric Administration, Space Weather Prediction Center. Retrieved 04.15.17 from http://www.swpc.noaa.gov/impacts/hf-radio-communications
[6] Stanford University, Stanford Solar Center. *Global Warming: Solar Issues on Climate.* Retrieved 04.15.17 from http://solar-center.stanford.edu/sun-on-earth/glob-warm.html

Section 3.17: Tornado



Washington County
April 2011
Source: Virginia State Police

Description

Tornadoes are rotating columns of air extending from a thunderstorm cloud to the ground. While most tornadoes measure less than 200 feet wide and have wind speeds less than 100 mph, severe tornadoes do occur with much broader swath widths and wind speeds approaching 200 mph, or even higher. Tornadoes with winds greater than 75 mph begin to cause significant structural damage to most buildings, but tornadoes with lower wind speeds can also cause damage, for example, by causing a tree to fall into a house.

In the US, tornadoes are classified on the Enhanced Fujita Scale (EF-Scale), assigning numeric scores from zero to five based on the severity of observed damages. The traditional Fujita scale, introduced in 1971, was used to rate the intensity of tornadoes thereafter, and was also applied to previously documented tornadoes. Starting in February of 2007, the EF Scale was implemented, with somewhat lower wind speeds at the higher F-numbers, and more refined structural damage indicator definitions. Table 3.17-1 compares the old and new tornado intensity scales.

In Virginia, tornadoes primarily occur from April through September, although tornadoes have been observed in every month. Compared to other states, Virginia ranks 28th in terms of the number of tornado touchdowns reported between 1950 and 2006; Midwestern and southern states ranked significantly higher[1]. Low-intensity tornadoes appear to occur most frequently; tornadoes rated EF2 or higher are very rare in Virginia, although EF2, EF3, and even a few EF4 storms have occurred[2]. The combination of WSR-88D (Weather Surveillance Radar, 1988, Doppler) and increased widespread use of GPS has resulted in increased efficiency in the identification and location of tornadoes, particularly those on the weaker end of the EF scale. This change in technology must be considered when examining the historic record and the frequency of tornadoes, especially those of weaker rating.

Table 3.17-1: Operational EF Scale Classifications in Relation to F Scale[3]

Fujita Scale			Derived EF Scale		Operational EF Scale	
F #	Fastest ¼ mile (mph)	3 Second Gust (mph)	EF #	3 Second Gust (mph)	EF #	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Historic Occurrence

Numerous low-intensity tornadoes are reported almost every year in Virginia. Figures 3.17-1 through 3.17-7 show the historic tornado touchdowns and tracks that have been recorded in the state between 1950 and 2016.

Of the more intense tornadoes which have occurred, a few recent incidents stand out[45]:

- On May 2, 1929 five tornadoes were reported in southwest Virginia, killing 22 people and injuring over 150 more. These tornadoes caused at least a half a million dollars in damages as four schools were destroyed.
- On March 4, 1944, what is thought to have been an F3 tornado tracked 30 miles through Lee, Wise, and Scott counties and injuring 32 people. Another tornado struck Washington County, injuring seven people and causing approximately $500,000 in total losses.
- On June 13, 1951, an F3 tornado went through the heart of Richmond creating a four-mile path and over one million in damages. Reports suggest that it was a multi-vortex tornado with four visible vortices.
- On August 6, 1993, four tornadoes were reported across southeast Virginia, ranging in intensity from F2 to F4. The F4 tornado impacted commercial and residential areas in Petersburg, Colonial Heights, and Hopewell, killing 4 people, injuring 246, and causing about $50 million in damages.
- On September 4, 1999, an F2 tornado caused about $7.7 million in damages in Hampton, as well as many injuries.
- On the afternoon of September 17, 2004, thunderstorms produced twelve tornadoes across the state, causing over $65 million in damages, with $54 million of the damages occurring at a factory in Fieldale.
- On April 28, 2008, an F3 tornado traveled from north of Suffolk to the Norfolk Naval Air Station, causing a total of $30 million in commercial and residential damage, with at least a dozen homes destroyed.

- On May 8, 2008, an EF2 tornado caused $10 million in damages in Berea (North of Fredericksburg); 160 homes damaged, with 25 rendered uninhabitable.
- On October 8, 2011, an EF2 tornado caused $3.9 million in damages in Pulaski County, resulting in 9 injuries. More than 200 homes reported having some damage with approximately 30 of those homes damaged beyond repair. On that same day, a tornado in Drapers Valley caused $1.4 million in damages.
- On April 16, 2011, fifteen tornados were reported in Virginia, ranging in intensity from an EF0 to an EF3. Of these tornadoes, 4 caused over a million dollars in property damages: Gloucester County $7.7 million, Augusta County $2.2 million, Dinwiddie County $1.5 million and Middlesex County $6 million. Because of these storms, there were 2 fatalities and 34 injuries.
- On April 28, 2011, twelve tornadoes were reported in Virginia, ranging in intensity from an EF0 to an EF3. Of these tornadoes, two caused over a million dollars in property damages and 5 deaths: Washington County $3 million and Smyth County $2.25 million.
- On October 13, 2011, eight tornadoes were reported in Virginia, ranging in intensity from an EF0 to an EF1. One of the EF1 tornadoes caused $1 million in property damages in New Kent, as this tornado damaged more than 30 homes in the Woodhaven Shores Subdivision.
- On March 2, 2012, an EF1 tornado caused $1.65 million in damages in Lee County of which $350,000 constitutes residential property loss, while $1.3 million is the estimated loss for agricultural property.
- On February 24, 2016, an EF3 tornado spanning a 16 mile stretch caused damages in Campbell and Appomattox Counties. The tornado caused seven reported injuries and one fatality[6].

Figure 3.17-1: Historic Tornado Touchdowns and Tracks: VDEM Region 1

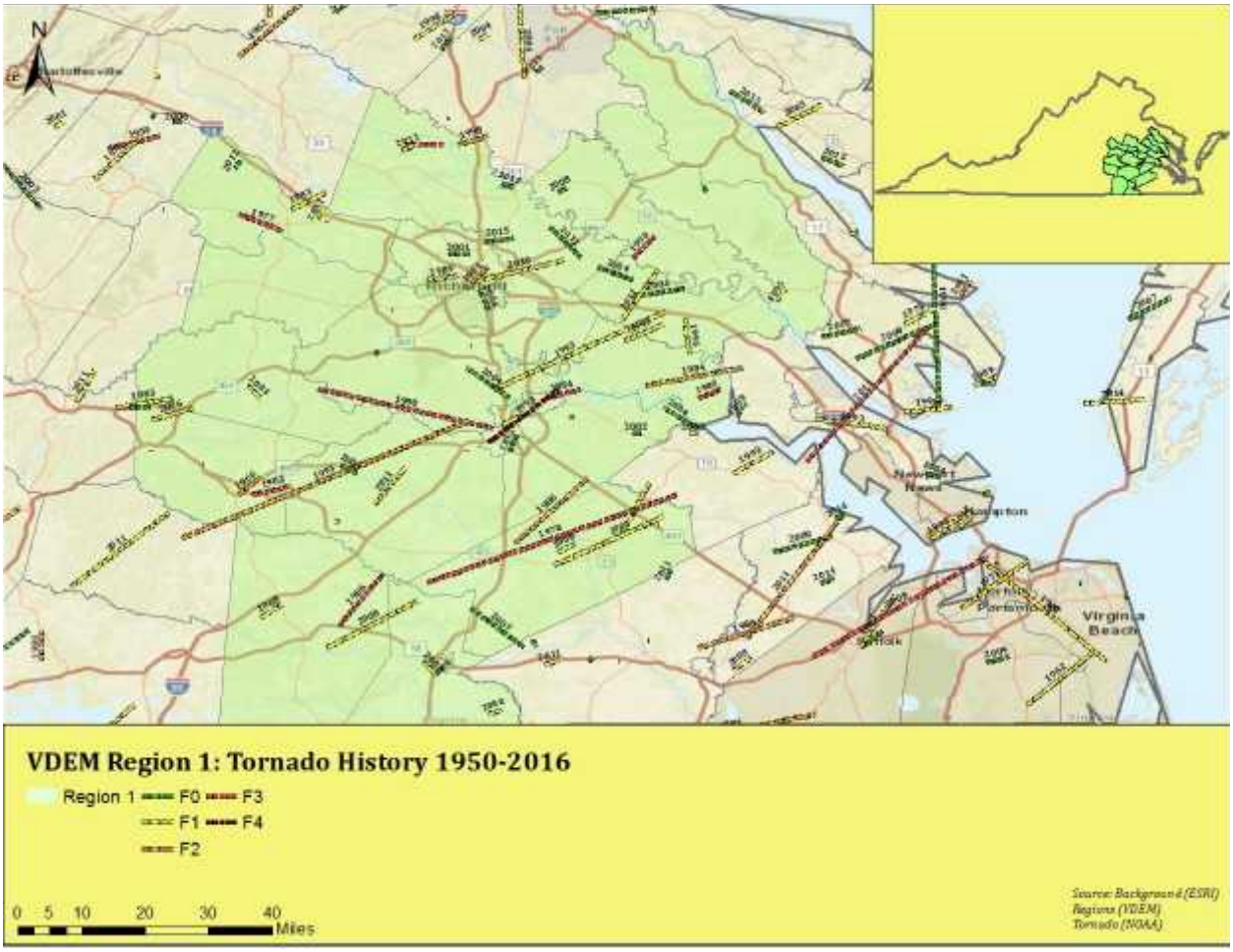


Figure 3.17-2: Historic Tornado Touchdowns and Tracks: VDEM Region 2

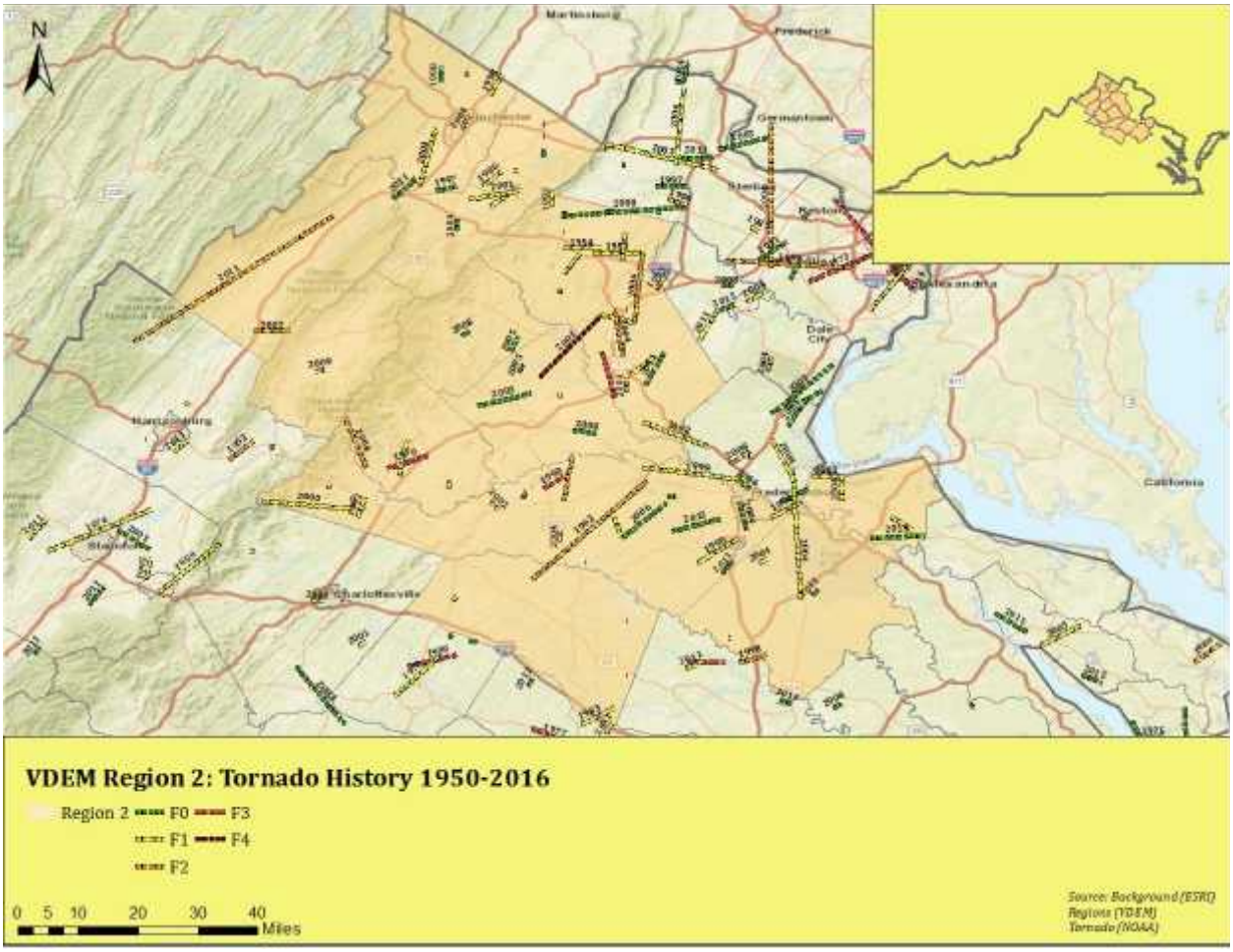


Figure 3.17-3: Historic Tornado Touchdowns and Tracks: VDEM Region 3

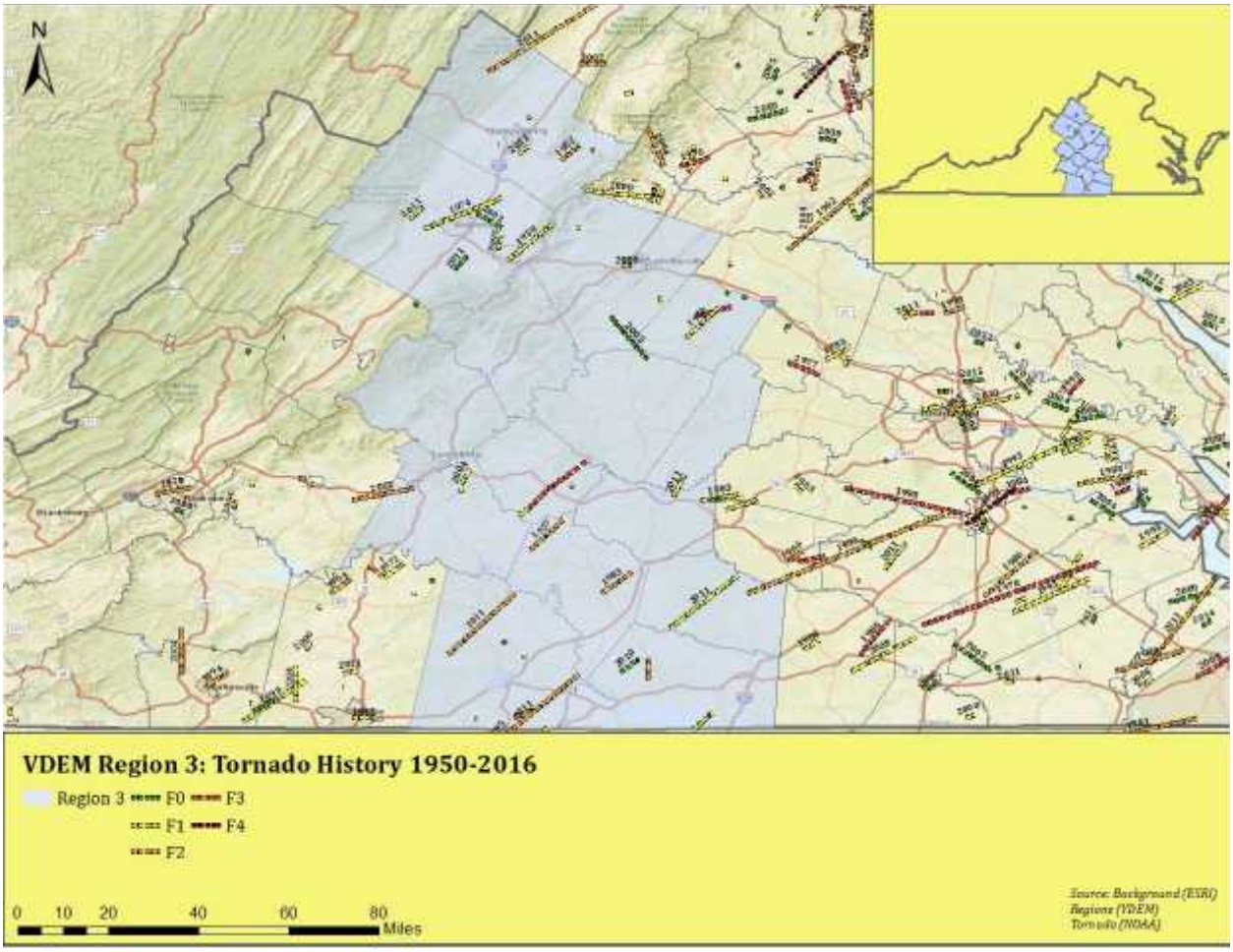


Figure 3.17-4: Historic Tornado Touchdowns and Tracks: VDEM Region 4

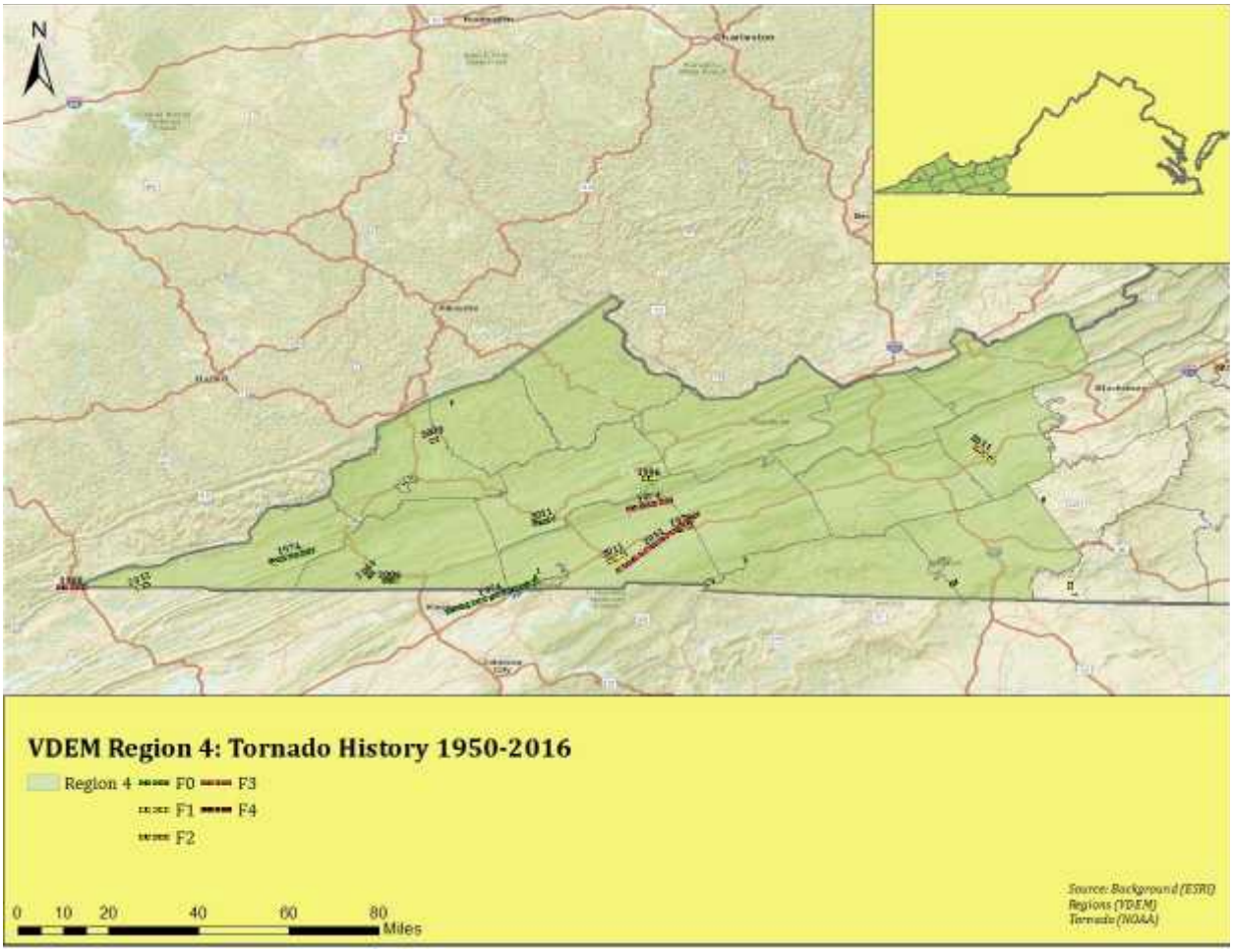


Figure 3.17-5: Historic Tornado Touchdowns and Tracks: VDEM Region 5

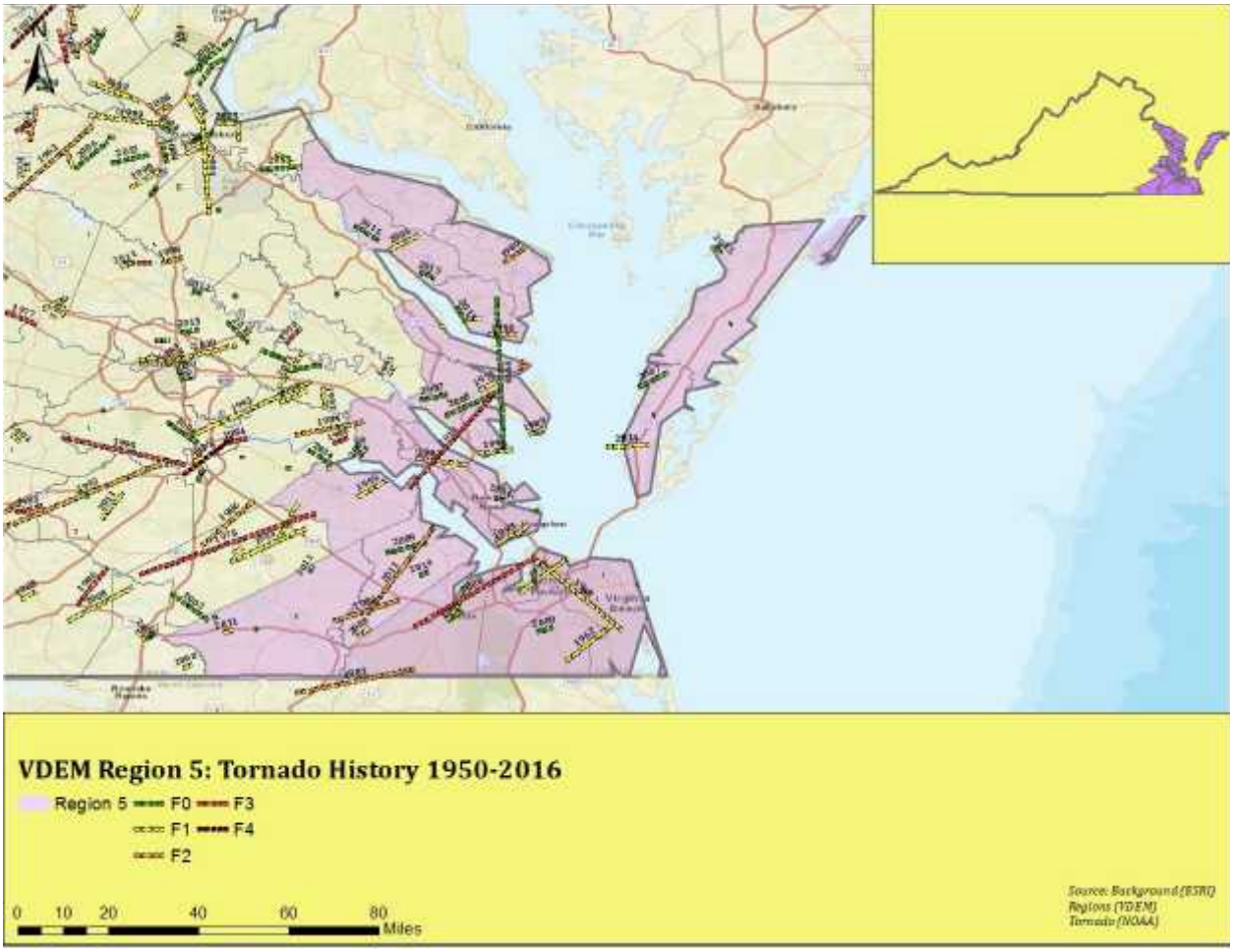


Figure 3.17-6: Historic Tornado Touchdowns and Tracks: VDEM Region 6

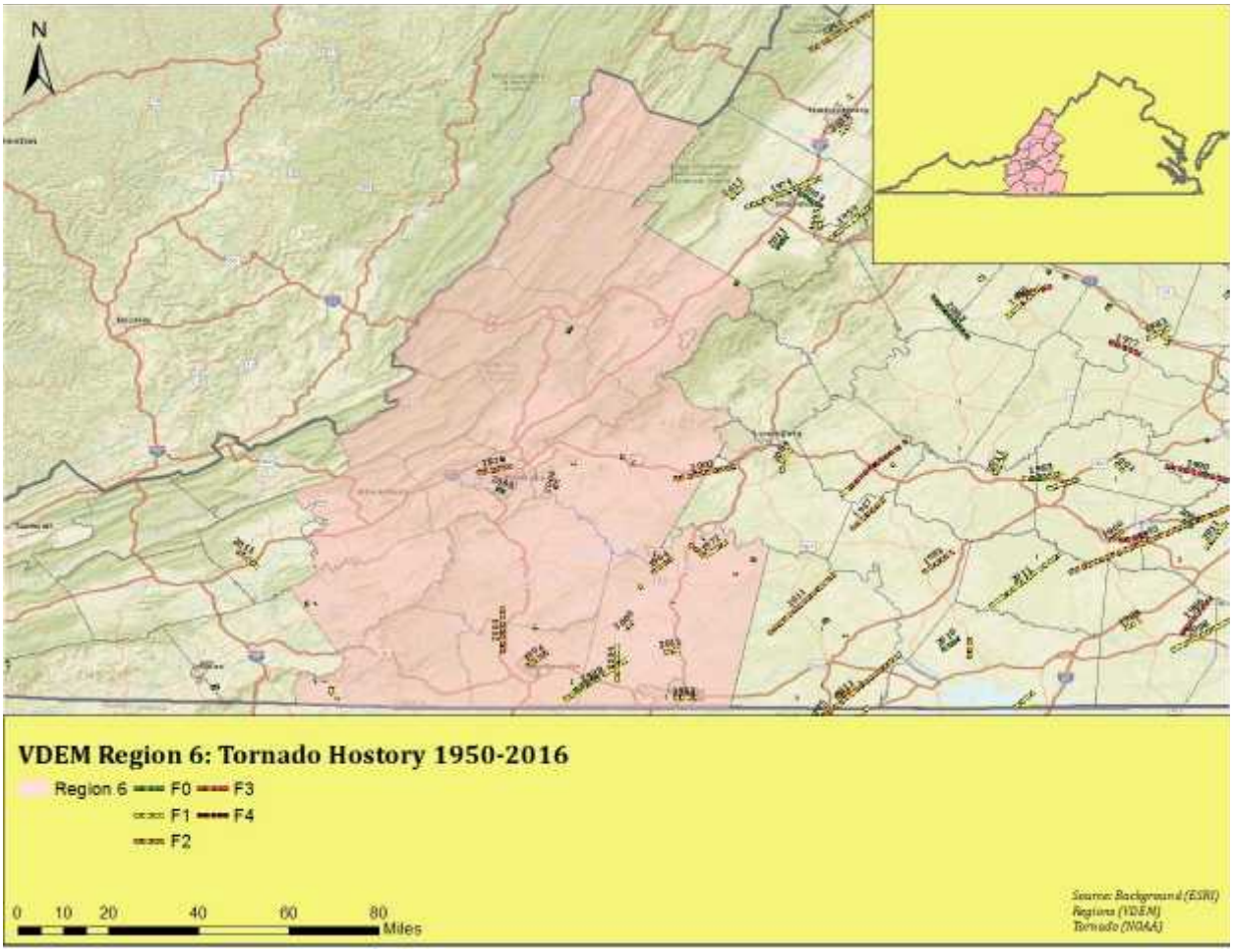
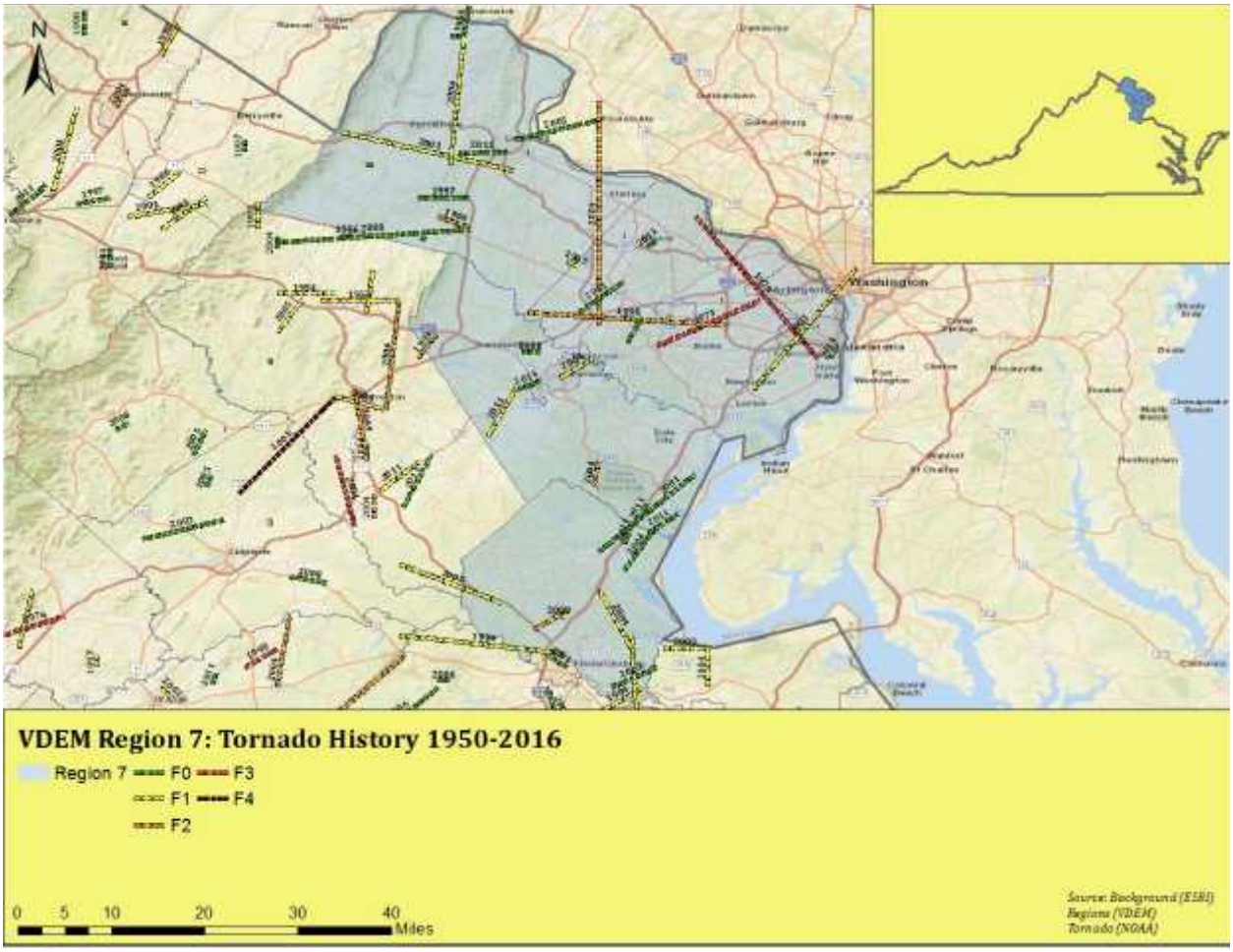


Figure 3.17-7: Historic Tornado Touchdowns and Tracks: VDEM Region 7



Risk Assessment

Probability

Tornado formation is a complex process for which it is difficult to develop a physically-based model. The simplest way to estimate the probability of future tornadoes is to analyze historical tornado incidence data and generate descriptive statistics, such as the frequency of occurrence. Records of historical tornadoes are maintained by the NCEI and by the National Weather Service's Storm Prediction Center. Tornado incidence is rare, especially in Virginia, and the available historic data is insufficient to estimate tornado probability conclusively. Therefore, while the data can be used to show the geographic variation in tornado frequency, such data should not be taken as an exact determination of tornado probability.

John Hart, at the National Weather Service Storm Prediction Center in Norman Oklahoma, has developed a graphical program, SeverePlot[7], to display a database of tornado occurrence that was derived from the NCEI *Storm Events Database*. This database dates from 1950 to 2006, and contains data on hail and high wind. Bryan Smith, with the National Weather Service in Indianapolis, has converted the SeverePlot program data into shape files which are ready to use in GIS software; these files are collectively referred to as SVRGIS[8]. Other researchers have developed tornado databases extending further back into history, or which contain additional attributes. However, the SVRGIS dataset, based on SeverePlot data, was sufficient for this analysis.

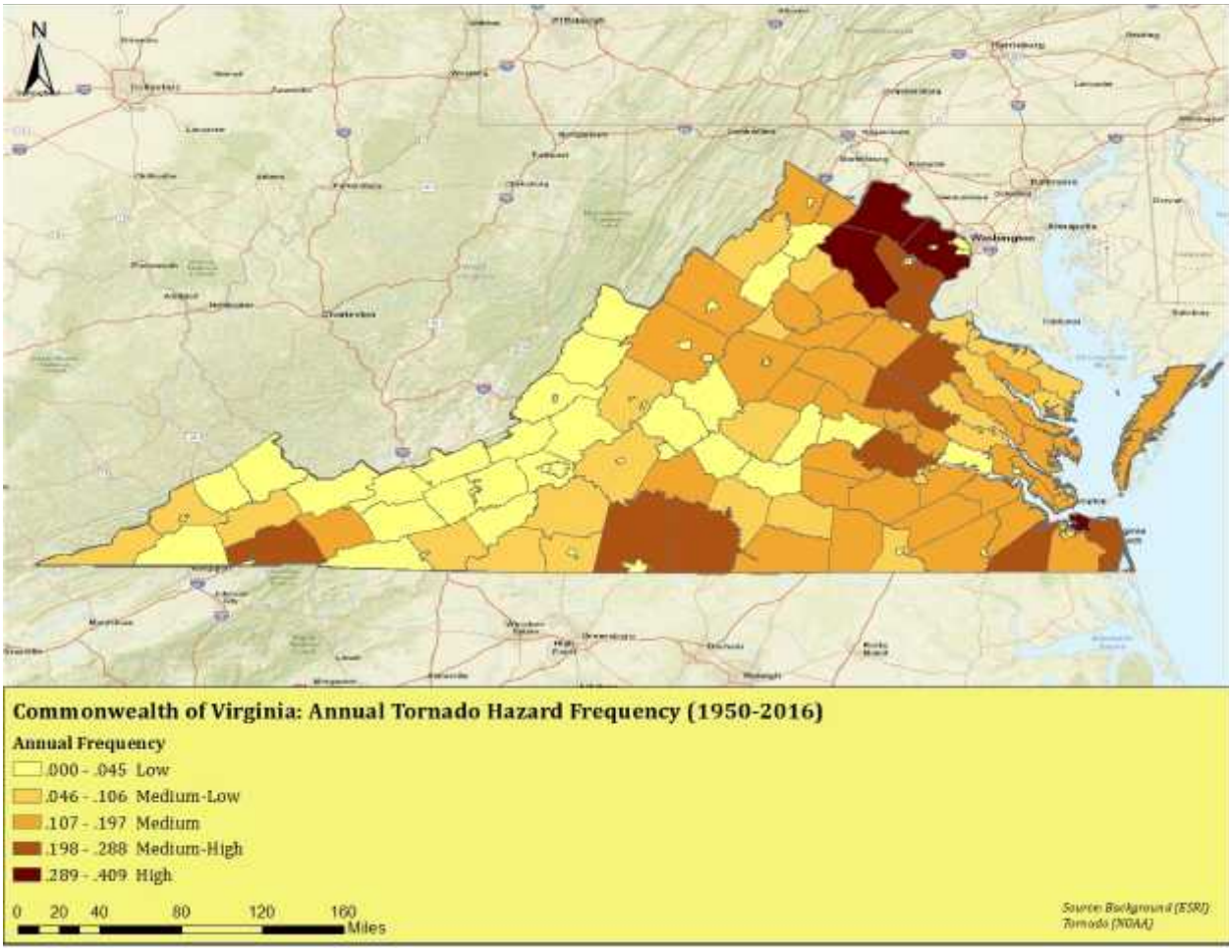
In reviewing the historic tornado database, a few important points must be made. First, tornado reports only go back to 1950, resulting in a limited historical record. Next, there are vastly higher numbers of low-intensity (EF0 and EF1) tornadoes reported in recent decades. The consensus among climatologists is not that there are more low-intensity tornadoes occurring in recent years; rather, it is that with increased population and advanced technology (such as WSR-88D, discussed earlier), more of these low-intensity tornadoes are observed and documented than were historically. Finally, while tornadoes are reported throughout the state, there are more tornadoes reported in areas of higher population. This may be due in part to the fact that many population centers are in areas where tornadoes are likely to occur, but the correlation is probably also indicative of human bias in reporting. Conversely, the mountainous counties in the western part of the state have lower populations and in some cases, no reported historical tornadoes, but tornado occurrence is still theoretically possible, albeit less probable.

The frequency analysis conducted on the available tornado data consisted of tabulating the area impacted by tornadoes for individual counties. The tornado hazard frequency is calculated as the total number of tornadoes within the jurisdiction divided by the number of years in the period of record.

The results of the tornado frequency analysis show a higher incidence of tornadoes in the northern and eastern parts of the state, and a lower incidence of tornadoes in the mountainous western parts of the state. These results can be seen in Figure 3-17.8. It is important to note that the data used for this analysis contains biases which may result in frequency estimates that may not have a meteorological substantiation, and may be biased by other factors.

Despite concerns about biases in the historical data, the results of the probability analysis provide a possible depiction of the relative tornado risk in different regions of the state. Finally, while the overall statewide probability of tornadoes is low relative to many other states, the probability of tornadoes in Virginia should not be overlooked, especially in the eastern parts of the state.

Figure 3.17-8: Annual Tornado Hazard Frequency



Impact and Vulnerability

Tornado vulnerability is based on building construction materials and standards, availability of safe rooms, and advanced warning system capabilities. Low-intensity tornadoes may not destroy a well-constructed building, although even the most well-constructed buildings are vulnerable to the effects of a more intense (EF2 or higher) tornado. In cases involving intense tornadoes, the best defense against injury or death is a properly engineered safe room or tornado shelter.

Tornadoes are high-impact, low-probability hazards. The net impact of a tornado depends on the storm intensity and the vulnerability of development in its path. An intensity-damage relationship for tornadoes would need to consider a variety of variables, and such a relationship has not been established for Virginia. Theoretically, an intensity-damage relationship could be estimated based on an analysis of reported damages, but such an analysis was beyond the scope of this planning process. In FEMA's Benefit-Cost Toolkit, the calculations to determine whether tornado shelter construction is justified are based on injuries and fatalities prevented, not total economic loss[9]. This approach was based on relationships between injuries/fatalities, tornado F-scale, and basic building construction type.

Risk

A formal calculation of annualized tornado risk, as a function of probability and impact, has not been performed for this analysis. Tornado probability has been quantified in terms of historical hazard frequency, and despite concerns regarding population bias in the original reporting, the results of the tornado hazard frequency analysis provide a reasonable estimation of the relative tornado hazard probability across the state. However, tornado impact has not been quantified in the form of an intensity-damage relationship that could be used for tornado damage prediction.
Rough estimates of annualized losses due to tornadoes can be generated based on the NCEI *Storm Events Database*, which documents the damage costs associated with many tornadoes. In the 23 years from 1993 through 2016, NCEI reports an annualized average of approximately $20 million in damages per year.

Tornado hazard zones were developed from the annual tornado hazard frequency results. This scoring system, as shown in Table 3.17-2, is used to identify facilities at risk, and to identify the jurisdictions exposed to the greatest tornado hazards.

Table 3.17-2: Tornado Hazard Frequency Scores

Tornado Hazard Zone	Annual Tornado Hazard Frequency
Low	.00 - .045
Medium-Low	.045 - .106
Medium	.107 - .197
Medium-High	.198 - .288
High	.289 - .409

State Facility Risk

State facility risk was determined by intersecting the VAPS facilities with the annual tornado hazard frequency layer. Risk for building polygons was determined by taking the area weighted average for the building and assigning a risk category based on the results. Intensity-damage information due to tornadoes has not been quantified at this time; as a result, annualized loss estimates have not been calculated for state facilities.

As shown in Table 3.17-3, when these categories are applied to the Virginia state-owned/operated facilities database (VAPS), many facilities are identified as being in the medium-high and high tornado hazard zones. Since the more urbanized eastern portions of the state are also the areas of higher tornado hazard, these results are not surprising.

Table 3.17-3: State Facilities in Tornado Hazard Zones

Tornado Hazard Zone	Number of State Facilities
Low	5,343
Medium-Low	1,569
Medium	4,187
Medium-High	1,522
High	179
Unable to Determine	3
Total	**12,803**

The results of this analysis indicate 179 buildings are at high risk for tornados. Eleven different state agencies are situated within the high risk zone. These agencies and the number of buildings are listed in table 3.17-4. The buildings listed represent slightly more than one percent of the buildings owned by the state.

Table 3.17-4: State Agencies with Assets in the High Risk Zone

Agency	Number of Buildings in High Hazard
Virginia Department of Alcoholic Beverage Control	4
Virginia Department of Conservation and Recreation	23
Virginia Department of Game and Inland Fisheries	4
Virginia Department of Motor Vehicles	6
Gunston Hall Home	26
George Mason University	6
Gunston Hall Plantation	1
Northern Virginia Community College	1
Virginia Community College System	19
Virginia Department of Transportation	49
Virginia Polytechnic Institute and State University (Virginia Tech)	39
Total	**179**

Critical Facility Risk

Critical facilities were intersected with the annual tornado hazard frequency layer to determine the corresponding risk zone. The results of this analysis are in table 3.17-5. Many food service/storage, fuel storage/delivery, and hazardous materials storage facilities are identified as being in the medium-high or high tornado hazard zones. Less than one percent of critical facilities are in high tornado hazard zones. Intensity-damage information due to tornadoes has not been quantified at this time; as a result, annualized loss estimates have not been calculated for critical facilities.

Table 3.17-5: Critical Facilities in Tornado Hazard Zones

Critical Facility Use	Low Risk	Medium-Low Risk	Medium Risk	Medium-High Risk	High Risk
Airfield	0	0	2	0	0
Animal Health	0	0	9	0	0
Armory	0	6	4	4	0
Childcare	6	0	4	0	0
Communications	31	11	30	4	1
Emergency Operations Center	1	0	0	0	0
Fire Service/ Support/Suppression	12	8	12	3	0
Food Service/Storage	30	10	32	14	2
Fuel Storage/Delivery	187	102	147	68	6

Critical Facility Use	Low Risk	Medium-Low Risk	Medium Risk	Medium-High Risk	High Risk
Hazardous Materials Storage	141	87	140	58	3
Medical Services /Support/EMS	70	3	53	2	0
Public Safety/Security	66	32	84	19	0
Research	105	3	59	11	0
Special Populations Housing / Shelters	11	2	13	1	0
Utilities	249	81	235	75	8
Total:	**911**	**348**	**824**	**261**	**20**

Tornado Risk to Energy Pipelines

Severe wind and flying debris associated with tornadoes can affect pipelines by damaging the infrastructure that supports pipeline operations such as power and telephone and satellite communications. Some pipelines require above ground facilities for their operations, like pump stations. Wind and flying debris can damage these facilities, causing pipelines to be shutdown. In addition, severe wind events can make pipeline operation sites inaccessible, making it more difficult to repair damaged equipment and restore operations. In some cases, pipeline operators may proactively shutdown pipeline operations prior to the onset of severe weather, to mitigate potential damages; this may cause supply interruptions.

Future Conditions Considerations

The link between changing climate and tornado severity and frequency is currently unclear. One problem is that long-term trends are difficult to determine, as records only go back to the 1950s. Another issue is that as population centers have grown and shifted over time, the reporting of tornadoes has been inconsistent. Also, improved observation technology (such a Doppler radar) allows for detection of events that was not possible in earlier years.

Researchers are working to better understand how the fundamental elements required for tornado formation – atmospheric instability and wind shear – interacts with changing climate conditions. It is likely that a warmer, wetter climate will allow for more frequent atmospheric instability. However, it is also likely that a warmer climate will dampen the probability of wind shear. Recent trends observed in the Midwest are inconclusive. It is also possible that climate change would shift the traditional timing or expected locations for tornadoes, and have less impact on the total number of tornado occurrences.

Adding to the complexity of the determination is that tornadoes are too geographically small to be well simulated by existing climate models. Models can simulate some of the conditions that contribute to forming the storms that typically spawn tornadoes, and multiple studies have found that the conditions that produce the most severe storms are likely to occur more frequently in a warmer world, even if the total number of thunderstorms decreases (because of fewer weak storms). However, this does not conclusively show whether tornadoes should or will follow the same trend as their parent storms[10].

Jurisdictional Risk

The jurisdictional tornado hazard rank is based on NCEI *Storm Events Database* parameters, as well as the tornado hazard frequency analysis. The Geographic Extent score for a given jurisdiction is higher in areas with a higher tornado hazard frequency. These scores were assigned by calculating the area-weighted average tornado hazard frequency in each jurisdiction. Table 3.17-7 shows maximum geographic extent, as well as the other parameters, for tornado events on a countywide basis.

The overall tornado hazard rankings for jurisdictions in the Commonwealth were based on the geographic extent scores, population, and measures of historical impact from NCEI, including property damage, crop damage, and fatalities and injuries. The overall tornado hazard rank for the Commonwealth, shown in Table 3.17-7, shows that the jurisdictions facing the greatest tornado risk are mostly in the eastern and northern parts of the state, although a few jurisdictions in southern and southwest Virginia also receive an elevated risk rating. Some jurisdictions were not classified as being high risk to tornadoes in previous plans, but recent tornado events in these jurisdictions have elevated them to this ranking (for example, Gloucester, Washington, and New Kent Counties).

Based on this, the jurisdictions with a higher tornado risk include:

- Loudoun County
- King George County
- Augusta County
- Fauquier County
- Gloucester County
- Washington County
- Chesterfield County
- Isle of Wight County
- Prince William County
- Dinwiddie County
- City of Fredericksburg
- Stafford County
- James City County
- Fairfax County
- Prince George County
- City of Alexandria
- Arlington County
- City of Petersburg
- Nottoway County
- City of Hampton
- City of Newport News
- City of Richmond

- Hanover County
- Henrico County
- City of Virginia Beach
- New Kent County
- City of Colonial Heights
- City of Manassas
- York County
- Henry County
- City of Hopewell
- City of Suffolk
- City of Fairfax
- City of Chesapeake
- City of Portsmouth
- City of Norfolk
- Albemarle County
- Spotsylvania County

Tornadoes occur almost every year in Virginia, and their incidence is significantly higher in the south-eastern and northern parts of the state. Although some jurisdictions may have few (or no) reported tornadoes in the historical record, tornadoes can still occur in these jurisdictions.

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

18 of the 20 local plans gave tornado a hazard rank and provided a general description of tornados, statistics, and impacts. Some of the plans included tornado in the wind hazard for their region. A lot of ambiguity exists in how jurisdictions define specific hazards. This variability can drastically impact how the local plans are compared to each other; section 3.6 further addresses this issue.

Seven plans calculated annualized loss for tornado using the NCEI *Storm Events Database*. The database was also used in the ranking for this revision. Table 3.17-6 provides the local annualized loss values. Since both the local and statewide plan revisions relied on NCEI data, one would assume that the values should be identical. The difference in the loss estimates can be attributed to several factors, including the time period of the events and when the data set was obtained from NCEI. The statewide analysis uses events from 1950 through 2016, and the local plan updates were all completed at various times. NCEI used many different storm event categories in their database. The categories used in this analysis are fully described in section 3.3 and in Table 3.3-4; the categories used by the local plans were not provided.

Table 3.17-6; Local Plan Annualized Tornado Loss Estimates

PDC/Jurisdiction	Annualized Tornado Loss
Commonwealth Regional	$126,783
George Washington Regional	$291,780
Hampton Roads	$2,100,000
Northern Virginia	$209,662
Rappahannock-Rapidan RC	$469,000
Region 2000	$469,000
Richmond Crater	$2,900,000
West Piedmont	$2,863,682

Comparison with Local Ranking

Cumberland Plateau, George Washington, Northern Shenandoah Valley, Northern Virginia, and Southside Planning Districts all ranked tornado as a high hazard.

Overall, five PDC/local plans ranked tornado as high, seven as medium, and six as a low hazard. The average of the local plans for tornado was medium. The 2018 statewide analysis has ranked tornado medium-high. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). One local plan addressed how or if tornado hazards are considered for changes in development.

Table 3.17-7: Tornado Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Medium-High	Low	High	High	Medium
Albemarle	Medium-High	Medium	Medium-High	High	Low	Medium-High	Medium-High	Medium
Alexandria, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Alleghany	Low	Low	Low	Low	Low	Low	Low	Low
Amelia	Low	Low	Low	High	Low	Medium-High	Medium-High	Medium-Low
Amherst	Medium	Medium	Low	Low	Low	Low	Low	Low
Appomattox	Low	Low	Medium-Low	High	Low	Medium-Low	Medium-Low	Medium-Low
Arlington	High	High	Low	High	Low	Low	Low	Medium
Augusta	Medium-High	Medium	Medium	High	Low	High	High	Medium-High
Bath	Low	Low	Low	Low	Low	Low	Low	Low
Bedford	Medium-High	Medium	Low	High	Low	Medium	Medium	Medium
Bland	Low	Low	Low	Low	Low	Low	Low	Low
Botetourt	Medium	Medium	Low	Low	Low	Low	Low	Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Brunswick	Medium	Low	Low	High	Low	High	High	Medium
Buchanan	Medium	Low	Low	Low	Low	Low	Low	Low
Buckingham	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Campbell	Medium	Medium	Medium	High	Low	Medium-High	Medium-High	Medium
Caroline	Medium	Low	Low	Medium	Low	High	High	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Carroll	Medium	Medium	Medium-Low	Medium-High	Low	Medium-Low	Medium-Low	Medium-Low
Charles City	Low	Low	Low	Medium-High	Low	Low	Low	Low
Charlotte	Low	Low	Low	High	Low	Medium-Low	Medium-Low	Medium-Low
Charlottesville, City of	Medium	High	Low	Medium	Low	Low	Low	Medium-Low
Chesapeake, City of	High	Medium-High	Low	High	Low	Medium-High	Medium-High	Medium
Chesterfield	High	Medium-High	Medium-Low	High	Low	High	High	Medium-High
Clarke	Low	Medium	Low	Medium	Low	Medium-High	Medium-High	Medium
Colonial Heights, City of	Medium	High	High	High	Low	Low	Low	Medium
Covington, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Craig	Low	Low	Low	Low	Low	Low	Low	Low
Culpeper	Medium	Medium	Medium-Low	High	Low	High	High	Medium
Cumberland	Low	Low	Low	Low	Low	Low	Low	Low
Danville, City of	Medium	Medium-High	Low	Medium-High	Low	Low	Low	Medium-Low
Dickenson	Low	Low	Low	Medium	Low	Low	Low	Low
Dinwiddie	Medium	Low	High	High	Low	Medium-High	Medium-High	Medium
Emporia	Low	Medium-High	Low	Low	Low	Low	Low	Low
Essex	Low	Low	High	High	High	Medium-Low	Medium-Low	3
Fairfax	High	High	High	High	Low	High	High	High
Fairfax, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Falls Church, City of	Low	High	Low	High	Low	Low	Low	Medium-Low
Fauquier	Medium-High	Medium	Low	High	Low	High	High	Medium
Floyd	Low	Low	Low	Low	Low	Low	Low	Low
Fluvanna	Medium	Medium	Low	Medium-High	Medium-High	Medium-High	Medium-High	Medium
Franklin	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Franklin, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Frederick	Medium-High	Medium	Low	High	Medium	Medium-High	Medium-High	Medium
Fredericksburg, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Galax, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Giles	Low	Low	Low	Low	Low	Low	Low	Low
Gloucester	Medium	Medium	High	High	Low	High	High	Medium-High
Goochland	Medium	Medium	Low	Medium-High	Low	Medium-High	Medium-High	Medium
Grayson	Low	Low	Medium	Low	Low	Low	Low	Low
Greene	Medium	Medium	Medium	High	Low	Medium-Low	Medium-Low	Medium
Greensville	Low	Low	Low	Medium-High	Low	Medium	Medium	Medium-Low
Halifax	Medium	Low	Medium-High	High	Low	High	High	Medium
Hampton, City of	Medium-High	High	Medium	High	Low	Medium-High	Medium-High	Medium-High
Hanover	Medium-High	Medium	Low	High	Low	High	High	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Harrisonburg, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Henrico	High	Medium-High	Low	High	Low	High	High	Medium-High
Henry	Medium	Medium	Medium-High	High	Low	Medium	Medium	Medium
Highland	Low	Low	Low	Low	Low	Low	Low	Low
Hopewell, City of	Medium	High	Medium	High	Low	Medium-Low	Medium-Low	Medium
Isle of Wight	Medium	Medium	Low	Medium-High	Low	High	High	Medium
James City	Medium-High	Medium-High	Medium	High	Low	Medium-High	Medium-High	Medium
King and Queen	Low	Low	Low	Medium-High	Low	Medium-High	Medium-High	Medium-Low
King George	Medium	Medium	Low	Medium-High	Low	Medium	Medium	Medium
King William	Low	Low	Low	High	Low	Medium	Medium	Medium-Low
Lancaster	Low	Medium	Low	High	Low	Medium	Medium	Medium-Low
Lee	Medium	Low	Low	High	Low	Medium	Medium	Medium-Low
Lexington, City of	Low	High	Low	Low	Low	Low	Low	Medium-Low
Loudoun	High	Medium-High	Low	High	Medium-Low	High	High	Medium-High
Louisa	Medium	Medium	Low	Medium-High	Low	High	High	Medium
Lunenburg	Low	Low	Low	High	Low	Medium-Low	Medium-Low	Medium-Low
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Madison	Low	Low	Low	Medium-High	Low	Medium-High	Medium-High	Medium-Low
Manassas, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Manassas Park, City of	Low	High	Low	Low	Low	Low	Low	Low
Martinsville, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Mathews	Low	Medium	Low	Medium	Low	High	High	Medium
Mecklenburg	Medium	Low	Low	High	Medium-Low	Medium-High	Medium-High	Medium
Middlesex	Low	Medium	Low	High	High	Medium-High	Medium-High	Medium
Montgomery	Medium-High	Medium	Low	High	Low	Low	Low	Medium-Low
Nelson	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
New Kent	Low	Medium	Low	High	Low	Medium-Low	Medium-Low	Medium-Low
Newport News, City of	High	High	Low	High	Low	Medium-High	Medium-High	Medium
Norfolk, City of	High	High	Low	High	Low	High	High	Medium-High
Northampton	Low	Medium	Medium-Low	Medium	Low	Medium-High	Medium-High	Medium
Northumberland	Low	Low	Medium-Low	Medium	Low	Medium	Medium	Medium-Low
Norton	Low	Medium-High	Low	Low	Low	Low	Low	Low
Nottoway	Low	Low	Low	Medium-High	Low	High	High	Medium
Orange	Medium	Medium	Low	High	Low	High	High	Medium
Page	Medium	Medium	Low	Medium-High	Low	Low	Low	Medium-Low
Patrick	Medium	Low	Low	Medium	Medium-High	Medium-Low	Medium-Low	Medium-Low
Petersburg, City of	Medium	Medium-High	Low	High	Low	Medium-Low	Medium-Low	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Pittsylvania	Medium-High	Medium	Low	High	Low	High	High	Medium
Poquoson	Low	Medium-High	Low	Low	Low	Low	Low	Low
Portsmouth, City of	Medium-High	High	Low	High	Low	Medium	Medium	Medium
Powhatan	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Prince Edward	Medium	Medium	Low	Medium	Low	Low	Low	Medium-Low
Prince George	Medium	Medium	Low	Medium-High	Low	Medium-High	Medium-High	Medium
Prince William	High	Medium-High	Medium	High	Low	High	High	High
Pulaski	Medium	Medium	Medium-Low	High	Low	Low	Low	Medium-Low
Radford, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Rappahannock	Low	Low	Low	High	Low	Medium-Low	Medium-Low	Medium-Low
Richmond	Low	Low	Low	High	Low	High	High	Medium
Richmond, City of	High	High	Medium	High	Low	Medium-High	Medium-High	Medium-High
Roanoke	Medium-High	Medium-High	Low	High	Low	Medium-Low	Medium-Low	Medium
Roanoke, City of	Medium-High	High	Low	Medium	Low	Low	Low	Medium-Low
Rockbridge	Medium	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Rockingham	Medium-High	Medium	Low	Medium-High	Low	Medium-High	Medium-High	Medium
Russell	Medium	Low	Low	Medium	Low	Medium	Medium	Medium-Low
Salem, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Scott	Medium	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Shenandoah	Medium	Medium	Low	High	Low	Medium-Low	Medium-Low	Medium-Low
Smyth	Medium	Medium	Low	High	Low	Medium-High	Medium-	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
							High	
Southampton	Low	Low	Low	Medium-High	Low	High	High	Medium
Spotsylvania	Medium-High	Medium	Low	Medium-High	Medium-Low	High	High	Medium
Stafford	Medium-High	Medium-High	Low	High	Low	High	High	Medium
Staunton, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Suffolk	Medium-High	Medium	High	High	Low	High	High	High
Surry	Low	Low	Low	Medium-High	Low	Medium-High	Medium-High	Medium-Low
Sussex	Low	Low	Medium	High	Low	Medium-High	Medium-High	Medium
Tazewell	Medium	Medium	Low	Low	Low	Low	Low	Low
Virginia Beach, City of	High	High	Medium	Medium-High	Low	High	High	High
Warren	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Washington	Medium	Medium	High	High	High	High	High	High
Waynesboro, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Westmoreland	Low	Medium	Low	High	Medium	Medium	Medium	Medium
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Winchester, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Wise	Medium	Medium	Low	High	Low	Medium-Low	Medium-Low	Medium-Low
Wythe	Medium	Medium	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
York	Medium-High	Medium-High	Low	Low	Low	Medium-High	Medium-High	Medium

For the 2018 plan, the overall hazard ranking for tornado is medium-high.

Table 3.17-8: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts are expected to be severe for the event area, and moderate for the outlying areas.
Health and Safety of Response Personnel	Localized impacts could be serious as local responders are working within the impacted area, if they live within the impacted area then they may be displaced for an extended period.
Continuity of Operations	Damage to facilities/personnel around the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure around the event could be severe.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be severe for the impacted areas, soil stability impacted, area likely to be vulnerable to landslides. With a high potential for debris, HAZMAT may be an issue.
Economic and Financial Condition	Local economic and financial conditions may be impacted for a long period depending on duration and geographical area of the event, as well as the size and capabilities of the local jurisdiction.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient

Endnotes

[1] Determined from CGIT analysis of SVRGIS tornado database, discussed in the Probability section

[3] Storm Prediction Center. *Enhanced F Scale for Tornado Damage.* Verified 05.08.17 from http://www.spc.noaa.gov/faq/tornado/ef-scale.html
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[6] Climate Change Guide: Your Guide to a More Sustainable Future. May 8, 2017, from: http://www.climate-change-guide.com/tornadoes.html
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[9] Federal Emergency Management Agency. "Supplement to the Benefit-Cost Analysis Reference Guide." June 2011. Verified 04.17.17 from http://www.fema.gov/benefit-cost-analysis

[10] Center for Climate and Energy Solutions. *Tornadoes and Climate Change.* Retrieved 05.08.17 from https://www.c2es.org/science-impacts/extreme-weather/tornadoes

Section 3.18: Wildfire



Great Dismal Swamp Fire
2008
Source: Steve Earley and the Virginia-Pilot

Description

A wildfire is a fire occurring in the natural environment and is a serious and growing hazard over much of the US. Wildfires can pose a threat to life and property, particularly when they impact developed areas. An average of 5 million acres burn every year in the US because of wildfires, causing millions of dollars in damage. Each year more than 100,000 wildfires occur in the US, almost 90 percent of which are started by humans; the rest are caused by lightning. Weather is one of the most significant factors in determining the severity of wildfires[1]. Spring (March and April) and fall (October and November) are the main two seasons for wildfires in Virginia.

Wildfire is a unique hazard because its effects can be greatly altered by containment efforts during the event. According to the Virginia Department of Forestry (VDOF), there are three important factors that determine the formation of wildfire hazards: fuel, topography, and weather. These factors are generally most hazardous in the spring and fall, which are known as the wildfire seasons. Low relative humidity combined with windy conditions cause fuels on the forest floor to dry out quickly, increasing wildfire risk. Small diameter twigs and brush, leaf litter, conifer needles, and grasses have rapid fluctuations in moisture content, and can dry out in a matter of hours. This can heighten wildfire risk in a short period.

Drought is a hazard that also contributes to wildfire risk. Over long dry periods, even larger fuels such as medium to large diameter dead and dying woody debris can become dry and fuel large wildfires. Not only does this increase the risk of a wildfire igniting, but it also increases the spread, intensity, and overall danger of an event once it has occurred.

High intensity wildfire events have significant impacts on vegetation and groundcover that serves to stabilize the soil. Decreased soil stability greatly increases risk of localized landslides and flooding. These risks are greater in areas with steep topography. The effects can carry on for years in the forms of increased runoff and erosion.

Historic Occurrence

Wildfire occurrences have been documented across the Commonwealth. Seven jurisdictions have been included in federal disaster declarations for wildfire; these include Buchanan County, Dickenson County, Scott County, Shenandoah County, Page County, Albemarle County and Nelson County. Nelson County also has the most NCEI wildfire events recorded in the state.

Table 3.18-1 is based on available records from Virginia Department of Forestry (VDOF) and includes the dates of significant wildfire in Virginia during the past century. The VDOF was created by the General Assembly in part to respond to the hundreds of thousands of acres of fires that burned annually throughout the Commonwealth.

Table 3.18-1: Historical Wildfire Events from Virginia Department of Forestry.

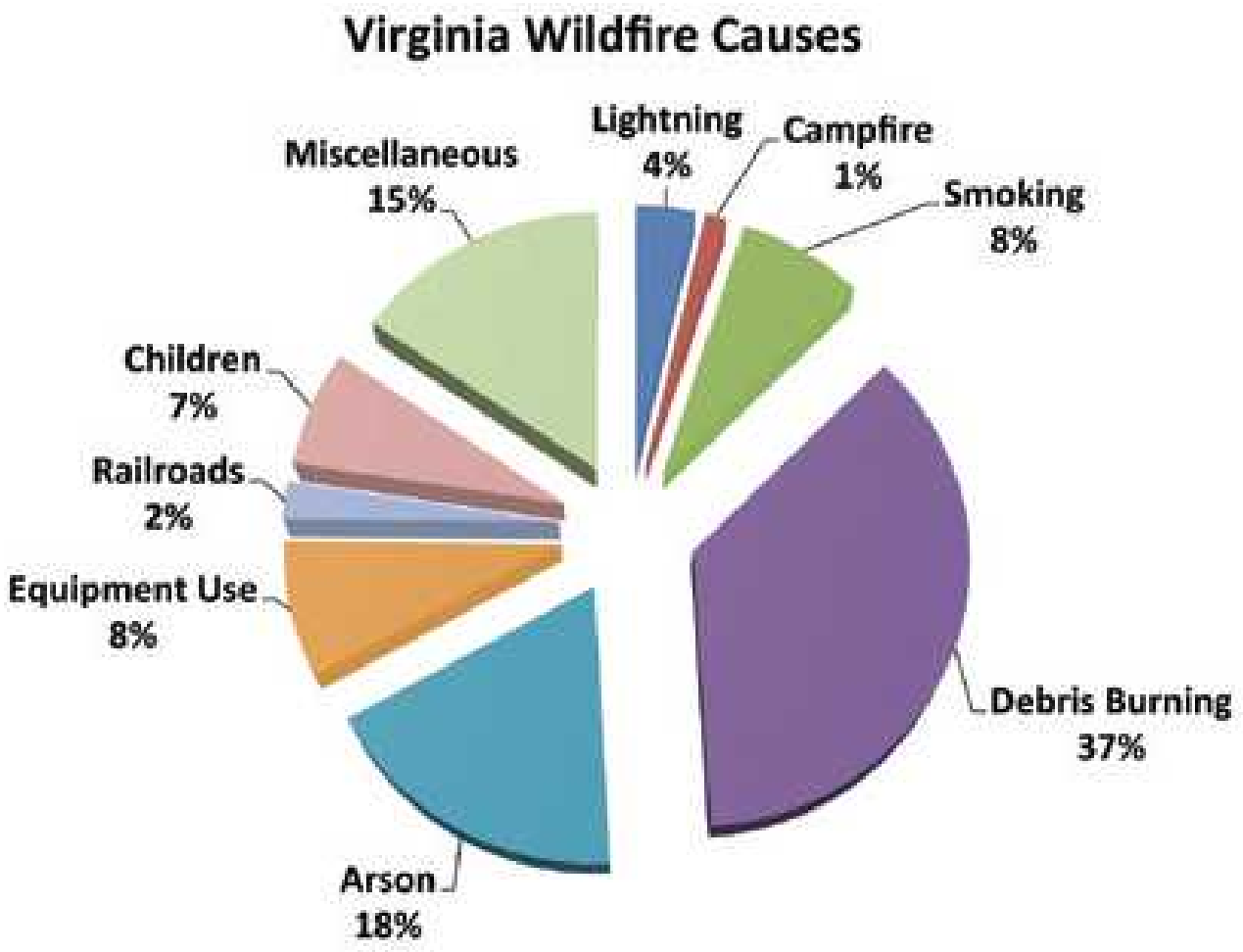
Year	Acres Burned	Damages	Description
1917	305,000	$809,000	Earliest known records in Virginia; over 1,460 fires were reported with two fatalities
1927	27,863		An all-time recorded low of 404 fires were reported for the state of Virginia.
1930	333,023		The year that the great draught occurred in Virginia. It was recorded that the year 'will long be remembered in Virginia, not only for its yearlong fire season and unprecedented, disastrous summer fires, but also because it brought disaster to many farmers and stockmen. Coming as it did immediately following the crash in the fall of 1929, its economic effects were severely felt.' 2,554 fires were recorded across 58 counties.
1941-1943			An average of 2,970 wildfires burn 148,937 acres each of the three years.
1948	7,782		The Smokey Bear Campaign was implemented in 1944. This campaign is one of the most successful advertising campaigns in American history and resulted in the first year that Virginia recorded less than 10,000 acres burned.
1952	111,571		2,494 fires burned 111,571 acres. It was the last time 100,000+ acres were burned in a single year.
1963	44,823		3,300 fires burned 44,823 acres in a year.
1982	11,170		More than 10,000 acres in eastern Virginia were destroyed by numerous spring wildfires.
1987	20,393		A dry summer and fall caused extreme fire conditions throughout the state. Governor Wilder considered cancelling fall hunting season as fires burned in southwest Virginia until a frontal system reduced the fire risk.

Year	Acres Burned	Damages	Description
1995	9,240	$1,258,541	On April 9, dry conditions, gusty winds, and deadwood resulted in 66 acres of forest burned in Buckingham County, 150 acres of forest burned in Franklin County requiring 65 residents to be evacuated, and 24 acres of forest burned in Pittsylvania County, all on the same day. Damage was estimated at about $50,000.
1998	6,480	$1,519,453	Dry conditions and rough terrain led to more than 2,000 acres being burned in one wildfire which occurred in the George Washington and Thomas Jefferson National Forest near Deerfield in Augusta County.
1999	15,663	$3,588,947	1,753 fires burned 15,663 acres. More than 400 acres on Afton Mountain burned on April 2, causing more than $2,000 in property damages. An overheated combine working in a wheat field during dry conditions on July 9 in White Post, Clarke County started a fire that burnt 67 acres, including 60 acres of wheat and the combine which resulted in $6,700 and $92,000 in damages respectively. The Cumulative Severity Index rated Northern Virginia at 628 by the end of July. (1-800 rating for fire danger).
2001	19,476	$13,205,274	This is the only year on record that required significant out-of-state resources, which included 12 USFS crews, 6 Florida Division of Forestry engines, and 1 Florida Division of Forestry plane and pilot. This is also the only year that wildfire funding assistance was received from FEMA. Like 1930, drought was a major cause of the large acreage that was burned.
2006	13,763	$12,465,881	Due to gusty winds and dry fuels, the Bull Mountain Fire in Patrick County burned more than 4,000 acres, including some vehicles and outbuildings.
2008	26,541	$12,706,576	February 10 saw the largest single day outbreak of wildfire in Virginia's recorded history. A strong dry cold front came through the Commonwealth bringing exceptionally high winds which lasted for more than 12 hours. The VDOF responded to 354 wildfires which ultimately burned 25,709 acres.
2009	8,779	$6.1 million	Wildfires burned 7,310 acres. Of the $6.1 million in damages, $5 million was timber damage and $1.1 million was property damage.
2010	5,071	$5 million	Wildfires burned 8,485 acres. Of the $5 million in damages, $4 million was timber damage and just under $1 million was property damage.

Year	Acres Burned	Damages	Description
2011	22,022	$15.7 million	Wildfires burned 14,272 acres. Of the $15.7 million in damages, $11 million was timber damage and $4.7 million was property damage. FEMA fire management assistance was given for the Smith and Coffman Fires which occurred in 2011.
2012	8,033	$3.9 million	633 fires burned 8,033 acres. Almost $2 million of timber was damaged and there was an additional $1.9 million of damage to homes and other buildings[2].
2013	4,730	$5 million	628 fires burned 4,730 acres. More than $2.3 million of timber was damaged and there was an additional $2.7million of damage to homes and other structures[3].
2014	12,675	$8.3 million	872 fires burned 12,675 acres. More than $6.8 million of timber was damaged and damage to homes and other buildings amounted to $1.5 million[4].
2015	4,941	$2 million	647 fires burned 4,941 acres. More than $740,000 of timber was damaged and damage to homes and other buildings amounted to $1.3 million[5].
2016	8,618	$6.9 million	498 fires burned 8,618 acres. More than $6.2 million of timber was damaged and there was an additional $759,000 of damages to homes and other structures[6].

Human activities are the leading cause of wildfire incidents in Virginia (as seen in Figure 3.18-1). Debris burning and the intentional setting of fires were responsible for the greatest number of reported wildfire incidents and acres burned during years 1995-2016. As suburban residential development continues to expand, it is reasonable to expect an increase in human/wildland interactions, resulting in more wildfires.

Table 3.18-1: Wildfire Causes in Virginia[7]



Risk Assessment

Probability

Future wildfire incidents are difficult to predict, as the factors influencing wildfire generation vary greatly with changing weather conditions, and with human activities. There is currently no quantitative estimate of future wildfire probability for specific regions of the state. While a VDOF Wildfire Risk Assessment does indicate the relative propensity for wildfires across the state, this assessment does not assign exact probabilities of occurrence. Based on the VDOF available data from 2015, the Commonwealth experiences an average of 1,000 wildland fires per year, affecting an average of 11,000 acres annually[8].

Probability for wildfire cannot be deduced into specific return periods or recurrence intervals as it can be for other hazards. As a result, analysis for wildfire was based on the VDOF Wildfire Risk Assessment dataset.

Impact & Vulnerability

Vulnerability to wildfire is influenced by a variety of factors, such land cover conditions, weather, and the effectiveness of land management techniques. Highly urbanized areas are less vulnerable to wildfire, but suburban neighborhoods located at the wildland/urban interface are more vulnerable to wildfire. Individual buildings may be vulnerable to damage from wildfire based on factors such as the clear distance around the structure, and the structure's construction materials.

The primary impacts of most wildfires are timber loss and environmental damage, although the threat to nearby buildings is always present. In the wake of a wildfire, secondary impacts may also include landslides and mudslides caused by the loss of groundcover which played a key role in stabilizing soil.

The VDOF thoroughly tracks the number of acres burned and estimated damages for each incident in the Commonwealth. Timing and coordination resulted in limitations in using this data as part of the ranking methodology. Future revisions of this plan will include this data, with modifications to fit within the ranking framework. Modifications would include further refinement of the VDOF data to distinguish timber damages from structural damages would provide a better understanding of the specific impacts of wildfire. See potential mitigation action items for further information on how this data could be incorporated in the next revision.

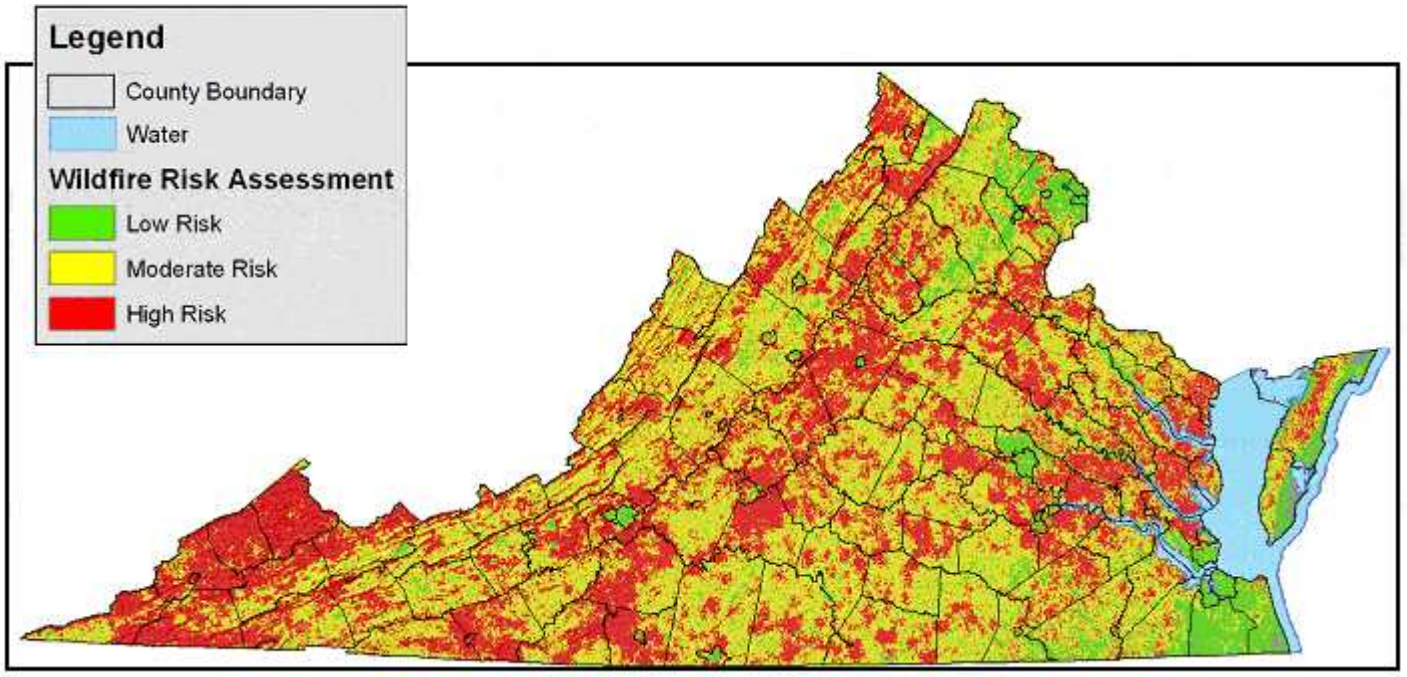
Risk

The risk associated with wildfire in Virginia has not been formally quantified, due to the lack of precise information on probability and impact. In 2002 and 2003, VDOF conducted a wildfire risk assessment based on GIS data layers and expert judgment. The VDOF examined which factors influence the occurrence and advancement of wildfires, and investigated how these factors could be represented in a GIS model. VDOF determined that the following inputs were important in modeling wildfire risk:

- Density of historical wildfires;
- Land cover (fuel);
- Percent slope;
- Slope orientation/aspect;
- Population density;
- Distance to roads;
- Railroad buffer; and
- Road density and developed areas.

These model parameters were combined to estimate the overall wildfire risk, although due to regional differences, the modeling process was conducted independently in each of the three physiographic regions (mountain, piedmont, and coastal plain). The results were merged, and the wildfire risks were classified and scored as: 1 (low), 2 (moderate), and 3 (high). Figure 3.18-2 shows the VDOF Wildfire Risk Assessment Layer.

Figure 3.18-2: VDOF Statewide Wildfire Risk Assessment



Risk of wildfire, in this plan, is focused on risk in terms of damages to infrastructure and population. The risk of fires starting or spreading is different and not discussed in detail in this plan.

The US Forest Service also maintains a dataset related to wildfire, known as the Wildfire Hazard Potential (formerly known as the Wildland Fire Potential). The WHP is a raster geospatial product that can help inform evaluations of wildfire risk or prioritizations of fuels management needs across very large landscapes (millions of acres)[9].

Figures 3.18-3 through 3.18-10 depict the current wildfire hazard potential for the state and for each VDEM Region.

Figure 3.18-3: Wildfire Hazard Potential, Virginia

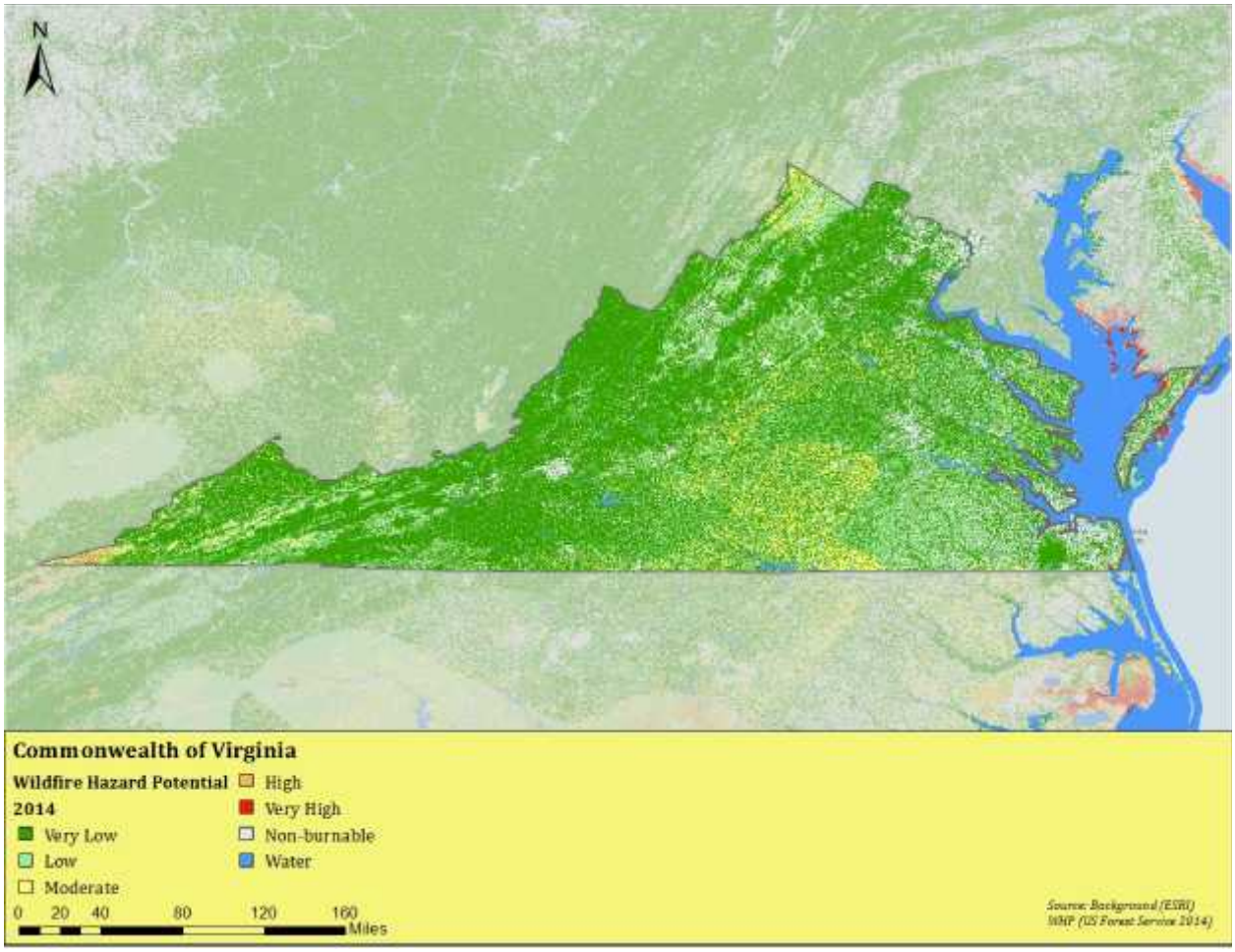


Figure 3.18-4: Wildfire Hazard Potential, VDEM Region 1

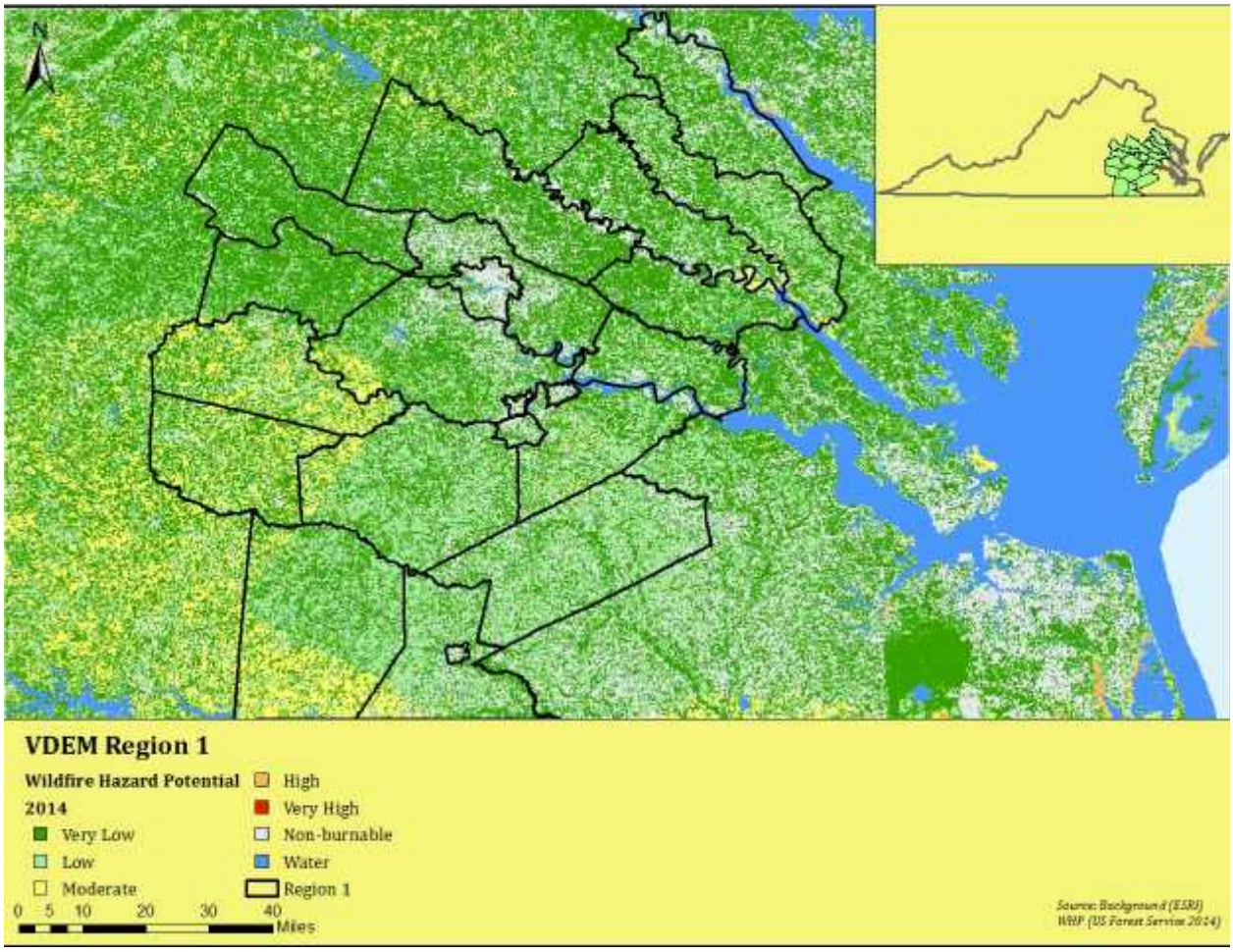


Figure 3.18-5: Wildfire Hazard Potential, VDEM Region 2

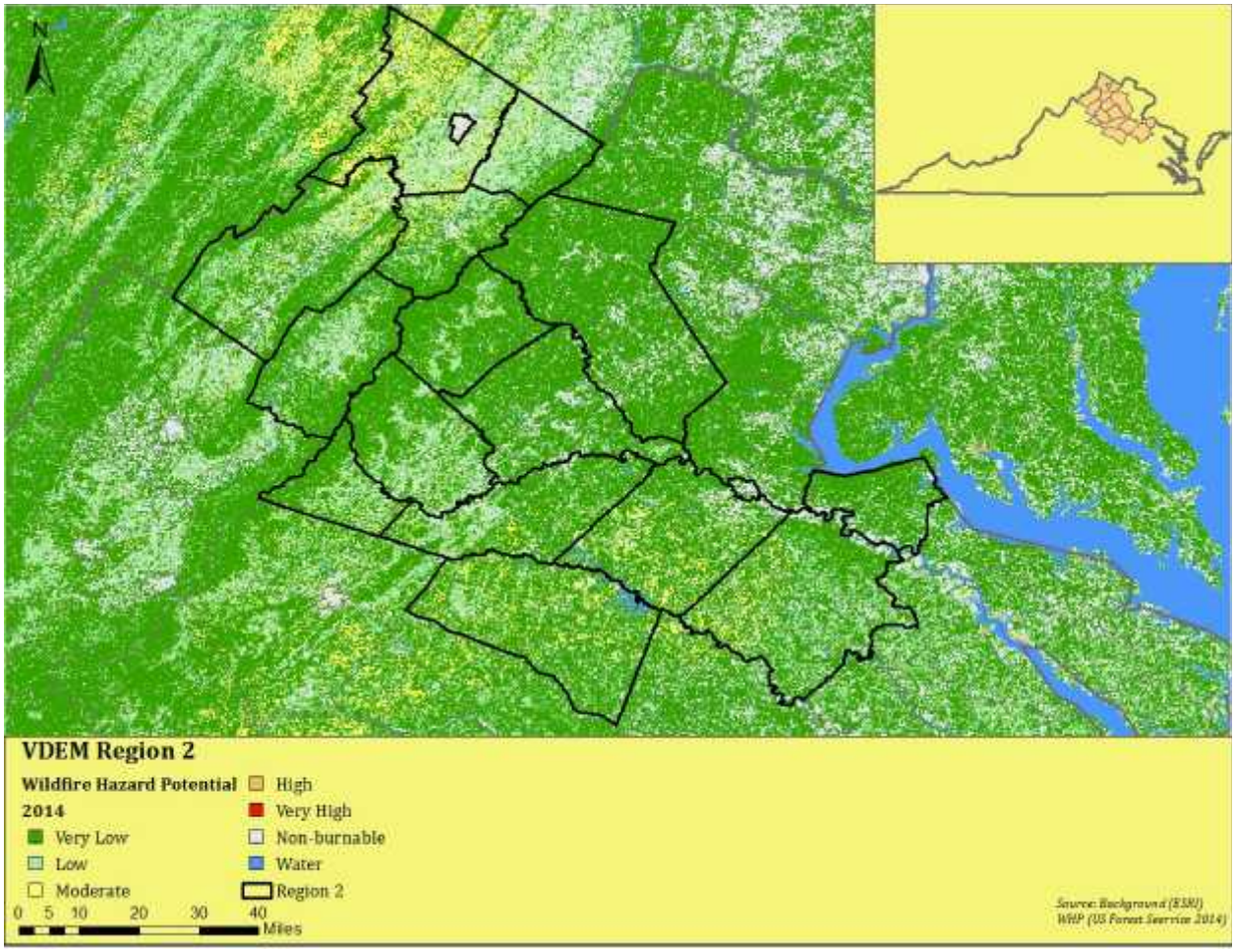


Figure 3.18-6: Wildfire Hazard Potential, VDEM Region 3

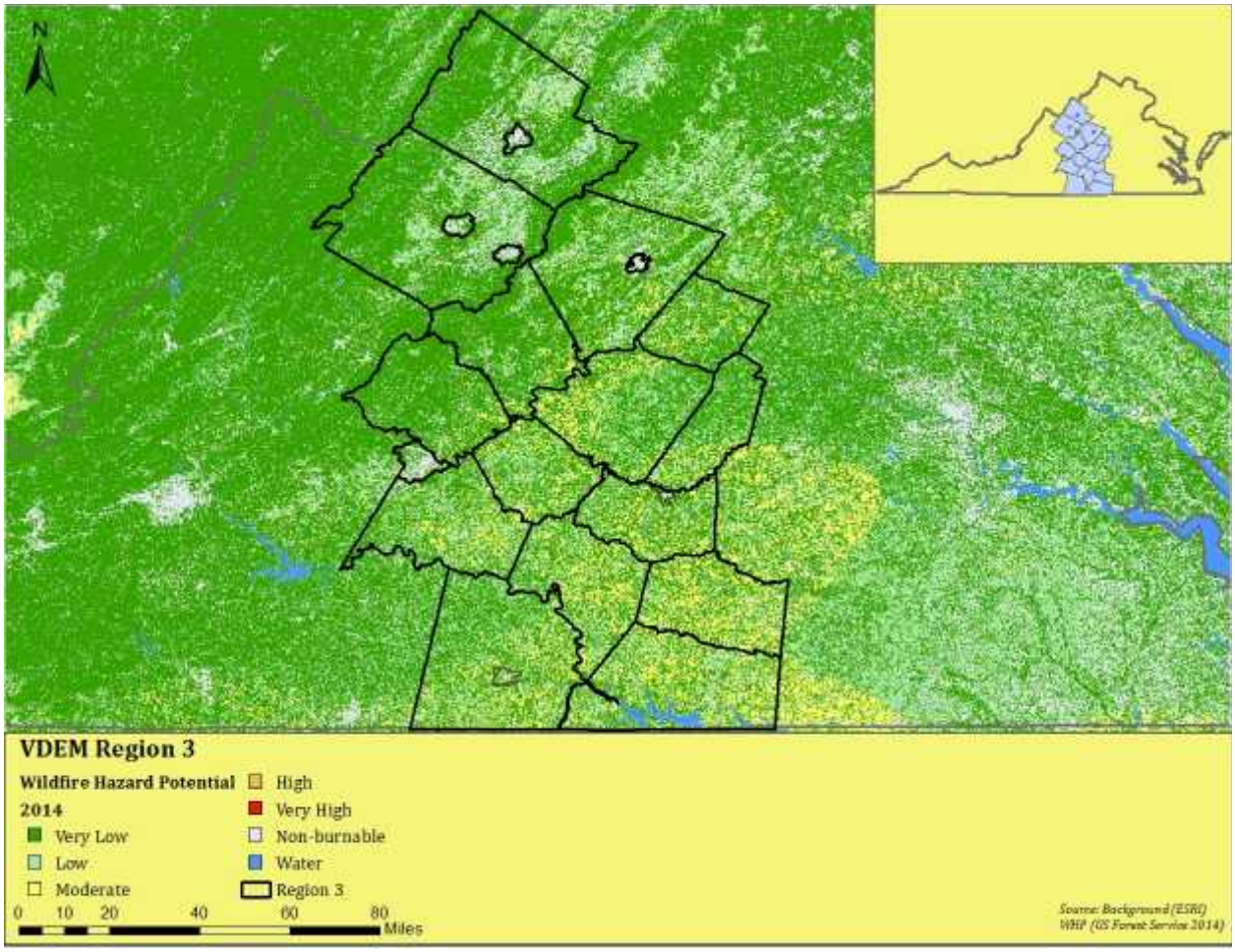


Figure 3.18-7: Wildfire Hazard Potential, VDEM Region 4

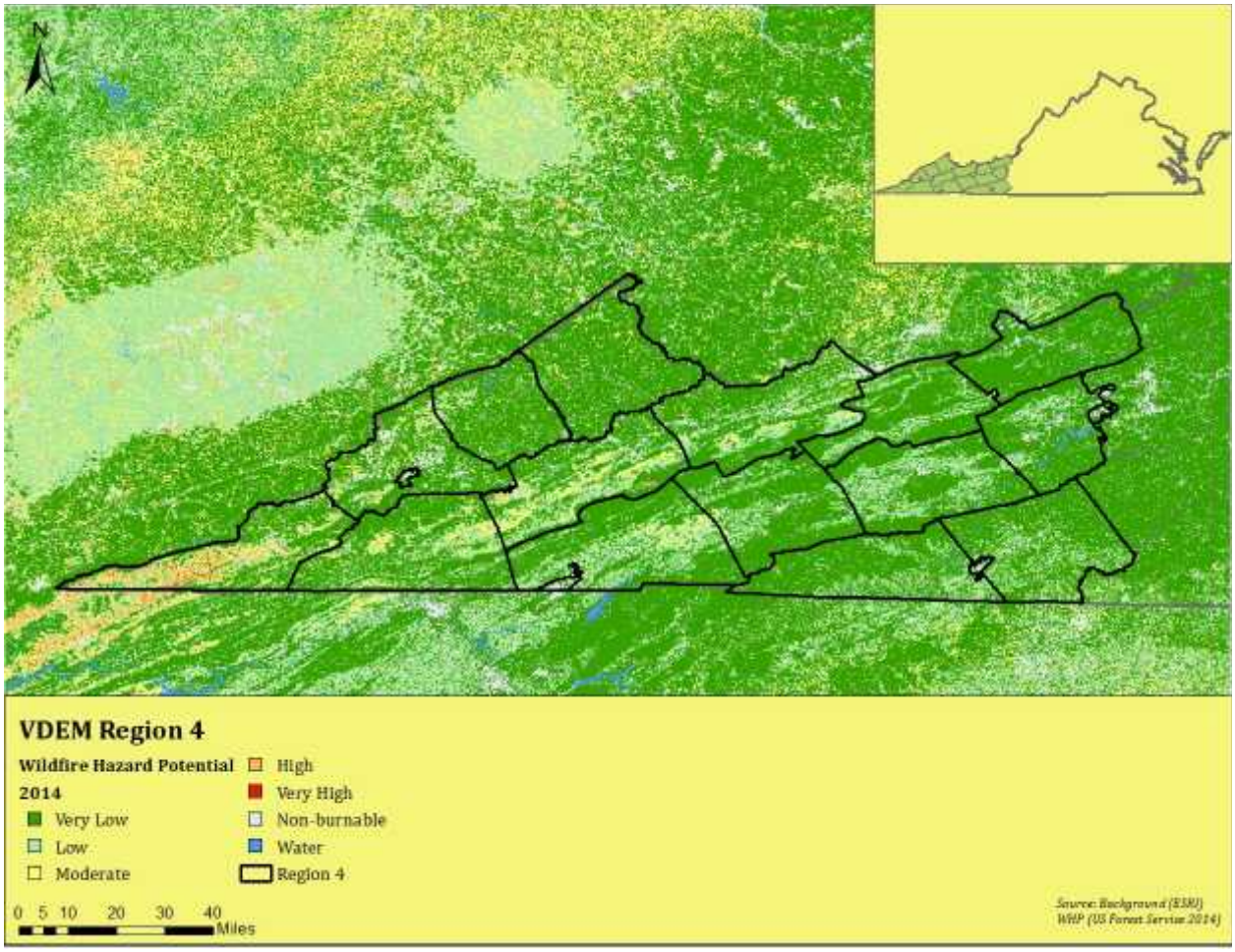


Figure 3.18-8: Wildfire Hazard Potential, VDEM Region 5



Figure 3.18-9: Wildfire Hazard Potential, VDEM Region 6

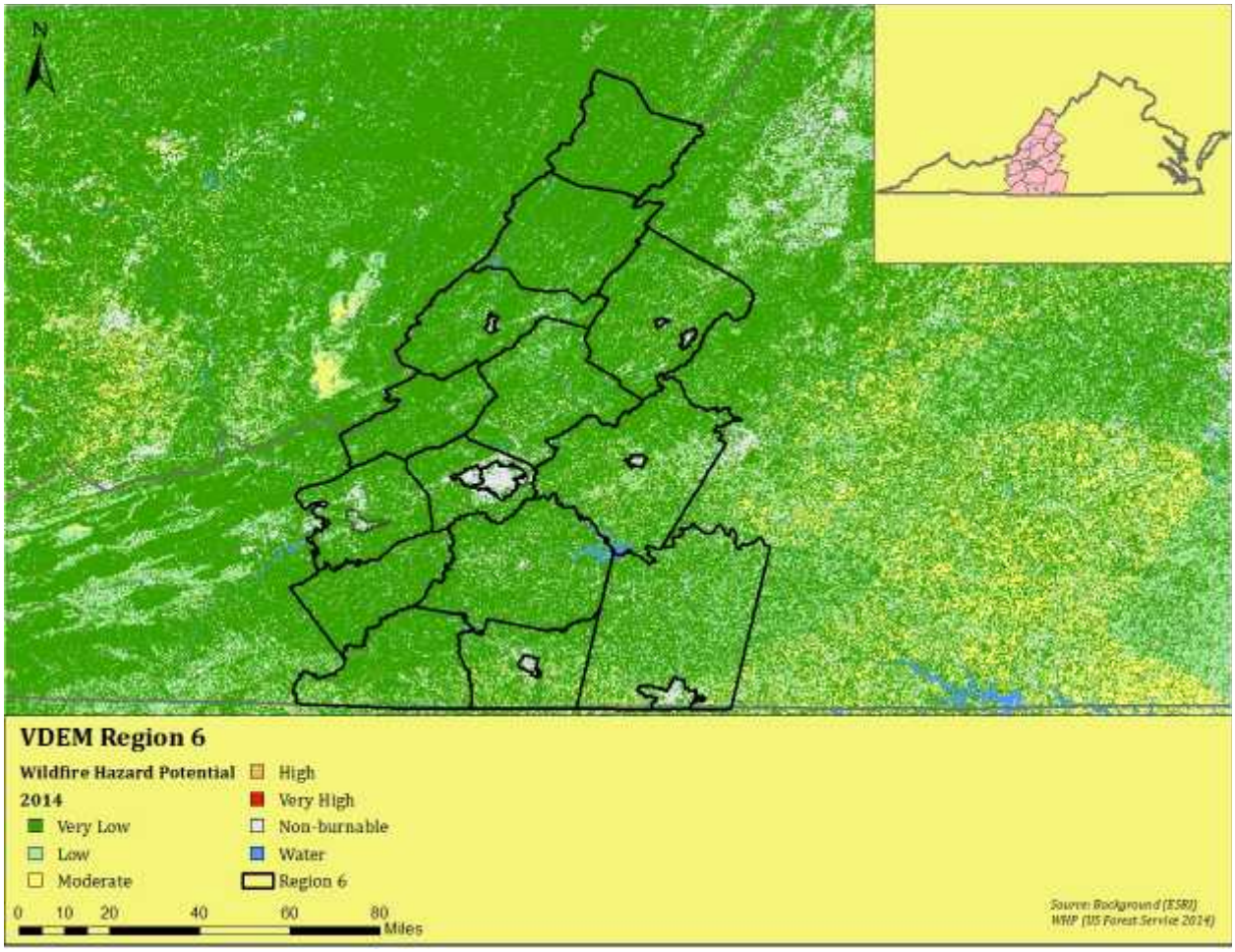
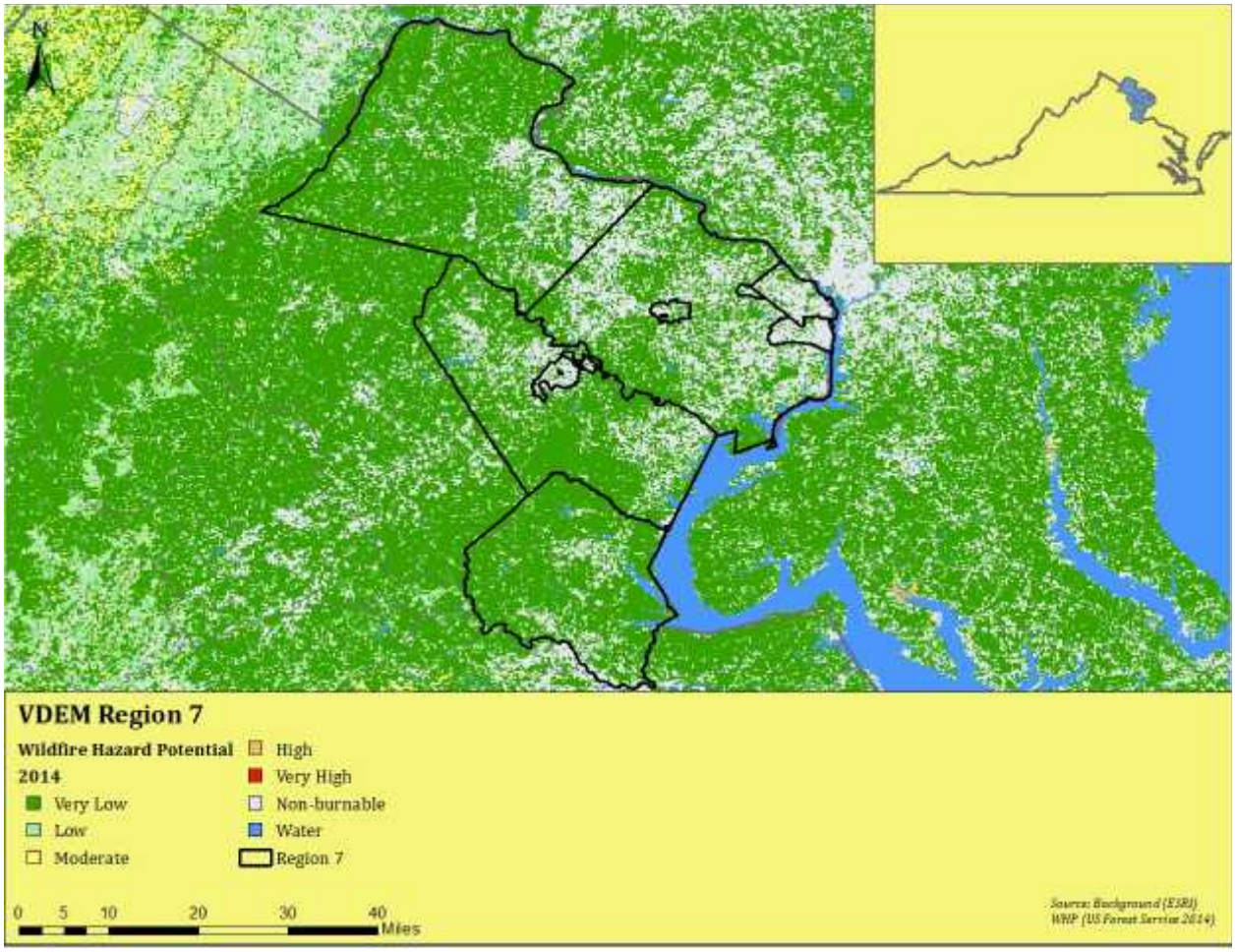


Figure 3.18-10: Wildfire Hazard Potential, VDEM Region 7



State Facility Risk

To determine what facilities were at risk for wildfire, the state facilities were intersected with the wildfire hazard potential layer. The results of this analysis indicate approximately less than one percent of state facilities are in high wildfire risk zones, and approximately one and one half percent are in moderate risk zones. The remaining 98 percent are in low risk zones. The lack of wildfire probabilities and detailed infrastructure data led to the inability to calculate potential losses due to wildfire.

Table 3.18-2 shows the facilities at risk for wildfire, broken down by the fire risk zone in which they are located.

Table 3.18-2: State facilities in Wildfire Risk Zones

Wildfire Risk Zone	Number of State Facilities
Low	12,585
Moderate	198
High	20
Total	**12,803**

The results of this analysis indicate approximately 20 buildings are at a high risk for wildfires and a two different state agencies are within this high potential zone. These two agencies are the Virginia Department of Conservation and Recreation and the Virginia Department of Game and Inland Fisheries.

Critical Facility Risk

The lack of wildfire probabilities and detailed critical facility data led to the inability to calculate potential losses due to wildfire. Risk for critical facilities was calculated in the same fashion as mentioned above for state facilities. Table 3.18-3 shows the breakdown of wildfire risk zones by critical facility type. The results of this analysis indicate less than approximately one percent of critical facilities are in high or moderate wildfire risk zones. Fuel storage/distribution and utilities are most critical facilities in high wildfire risk zones.

Table 3.18-3: Critical facilities in Wildfire Risk Zones

Critical Facility Use	High Risk	Moderate Risk
Airfield	0	0
Animal Health	0	0
Armory	0	0
Childcare	0	0
Communications	0	0
Emergency Operations Center	0	0
Fire Service/ Support/Suppression	0	1
Food Service/Storage	0	2
Fuel Storage/Delivery	1	8
Hazardous Materials Storage	0	8
Medical Services /Support/EMS	0	0
Public Safety/Security	0	4
Research	0	1

Critical Facility Use	High Risk	Moderate Risk
Special Populations / Housing / Shelters	0	26
Utilities	2	9
Total:	**3**	**59**

Wildfire Risk to Energy Pipelines

Wildfires can damage pipelines because of extreme heat or flame. In addition, other above ground facilities associated with operating the pipeline could be damaged, requiring the pipeline to be shut down. For example, a 2011 wildfire in Raton, New Mexico burned gaskets in Raton Natural Gas Company's pipeline valves[10].

Future Conditions Considerations

As the climate warms, the atmosphere can hold more moisture, and precipitation is likely to increase in winter but decline during the summer, leading to summertime soil moistures. Drier soils mean less evaporation and so the heat goes into higher temperatures, less recycled moisture in the atmosphere, and hence less rain during summer. With increased drying, it is a recipe for increased intensity, frequency and duration of drought. Increased heat waves and risk of conflagration follow[11].

Jurisdictional Risk

Wildfire hazard ranking is based on NCEI *Storm Events Database*, VDOF data, and population parameters as described in the Ranking Section (section 3.5). The parameters in the risk assessment are described in Table 3.18-4, along with the total ranking. The geographic extent score for a given jurisdiction is based on the percent of the jurisdiction that falls within the high-risk area as defined by VDOF. Most the Commonwealth is in the low and medium categories. There are relatively few records in NCEI for wildfire events; as a result, the lowest ranking score (1) was assigned to the majority of the annualized data for events, damages, and deaths and injuries to be able to compare wildfire to the other hazards. The ranking methodology is described in section 3.5.

Per NCEI crop and property damage data, the Commonwealth can expect approximately $744,950 in annualized damages per year for wildfire related events.

Based on VDOF data, the Commonwealth had approximately $2 million in annualized damages from 2014-2015. Although an average of 70 structures are damaged or destroyed by wildland fire each year, the agency protects, on average, more than 1,100 others, valued at $130 million[12].

One of the reasons for the difference in the two annualized loss estimates is a result of the VDOF data including all types of damages (such as timber, structures, and personal property) while the NCEI data only documents reported damages to property and crops. Additionally, the VDOF database is a much more complete record of all wildfires in Virginia, while NCEI is known to be an underestimate of the true quantity of events and damages – not just for wildfire, but for all event types. The difference also highlights the fact that wildfire is a predominant hazard in Virginia but seems to be mostly limited to highly forested and rural areas.

The following jurisdictions have been assigned a higher risk ranking for wildfire

- Clarke County
- Albemarle County
- Warren County
- Roanoke County

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

All local plans provided a general description of the hazard. Some of the local plans intersected the VDOF wildfire risk assessment GIS later with critical facilities and/or parcels to determine the percentage of structures at risk. Eight of the 20 local plans provided annualized loss estimates based on VDOF wildfire statistics. The annualized loss values from these plans have been compiled in Table 3.18-5. The loss values used for the statewide analysis are from the NCEI *Storm Events Database*. The VDOF dataset provides a more complete record of past wildfires and damages to the Commonwealth. Timing and coordination resulted in limitations in using this data as part of the statewide ranking methodology. The completeness of the VDOF data, as compared to the NCEI data, is evident in comparing the local results for Commonwealth RC ($229,381) to the statewide results ($2,952). This is consistent with the differences between NCEI and VDOF discussed in Jurisdictional Risk for the statewide annualized loss totals. The NCEI damages are for only crop and property while the VDOF loss includes all damages caused by the incident.

Table 3.18-5: Local Plan Annualized Loss

PDC/Jurisdiction	Annualized Wildfire Loss from Local
Commonwealth RC	$229,381
Central Shenandoah Valley	$3,954,588
Hampton Roads PDC	$27,208
Northern Virginia RC	$10,049
Rappahannock-Rapidan RC	$42,523
Richmond Crater	$152,941
Thomas Jefferson	$53,400
West Piedmont	$400,352

Comparison with Local Ranking

The Cumberland Plateau RC ranked wildfire as a high hazard. 11 of the 20 regional plans ranked wildfire as a medium-high hazard, and eight ranked as low. The average ranking of the local plans for wildfire was medium. The 2018 statewide analysis ranked wildfire as medium-low. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2).

Table 3.18-6: Wildfire Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Low	Low	Low	Low	Low
Albemarle	Medium-High	Medium	Low	Low	Low	Low	Medium	Medium-Low
Alexandria, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Alleghany	Low	Low	Low	Low	Low	Low	Low	Low
Amelia	Low	Low	Low	Low	Low	Low	Low	Low
Amherst	Medium	Medium	Low	Low	Low	Low	Low	Low
Appomattox	Low	Low	Low	Low	Low	Low	Low	Low
Arlington	High	High	Low	Low	Low	Low	Low	Medium-Low
Augusta	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Bath	Low	Low	Low	Low	Low	Low	Low	Low
Bedford	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Bland	Low	Low	Low	Low	Low	Low	Low	Low
Botetourt	Medium	Medium	Low	Low	Low	Low	Low	Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Brunswick	Medium	Low	Low	Low	Low	Low	Low	Low
Buchanan	Medium	Low	Low	Low	Low	Low	Low	Low
Buckingham	Low	Low	Low	Low	Low	Low	Low	Low
Buena Vista, City	Low	Medium-	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
of		High						
Campbell	Medium	Medium	Low	Low	Low	Low	Low	Low
Caroline	Medium	Low	Low	Low	Low	Low	Low	Low
Carroll	Medium	Medium	Low	Low	Low	Low	Low	Low
Charles City	Low	Low	Low	Low	Low	Low	Low	Low
Charlotte	Low	Low	Low	Low	Low	Low	Low	Low
Charlottesville, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Chesapeake, City of	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Chesterfield	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Clarke	Low	Medium	Low	Low	Low	Low	Medium	Low
Colonial Heights, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Covington, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Craig	Low	Low	Low	Low	Low	Low	Low	Low
Culpeper	Medium	Medium	Low	Low	Low	Low	Low	Low
Cumberland	Low	Low	Low	Low	Low	Low	Low	Low
Danville, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Dickenson	Low	Low	Low	Low	Low	Low	Low	Low
Dinwiddie	Medium	Low	Low	Low	Low	Low	Low	Low
Emporia	Low	Medium-	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
		High						
Essex	Low	Low	Low	Low	Low	Low	Low	Low
Fairfax	High	High	Low	Low	Low	Low	Low	Medium-Low
Fairfax, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Falls Church, City of	Low	High	Low	Low	Low	Low	Low	Low
Fauquier	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Floyd	Low	Low	Low	Low	Low	Low	Low	Low
Fluvanna	Medium	Medium	Low	Low	Low	Low	Low	Low
Franklin	Medium	Medium	Low	Low	Low	Low	Low	Low
Franklin, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Frederick	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Fredericksburg, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Galax, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Giles	Low	Low	Low	Low	Low	Low	Low	Low
Gloucester	Medium	Medium	Low	Low	Low	Low	Low	Low
Goochland	Medium	Medium	Low	Low	Low	Low	Low	Low
Grayson	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Greene	Medium	Medium	Low	Low	Low	Low	Low	Low
Greensville	Low	Low	Low	Low	Low	Low	Low	Low
Halifax	Medium	Low	Low	Low	Low	Low	Low	Low
Hampton, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Hanover	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Harrisonburg, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Henrico	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Henry	Medium	Medium	Low	Low	Low	Low	Low	Low
Highland	Low	Low	Low	Low	Low	Low	Low	Low
Hopewell, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Isle of Wight	Medium	Medium	Low	Low	Low	Low	Low	Low
James City	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
King and Queen	Low	Low	Low	Low	Low	Low	Low	Low
King George	Medium	Medium	Low	Low	Low	Low	Low	Low
King William	Low	Low	Low	Low	Low	Low	Low	Low
Lancaster	Low	Medium	Low	Low	Low	Low	Low	Low
Lee	Medium	Low	Low	Low	Low	Low	Low	Low
Lexington, City of	Low	High	Low	Low	Low	Low	Low	Low
Loudoun	High	Medium-	Low	Low	Low	Low	Low	Medium-

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
		High						Low
Louisa	Medium	Medium	Low	Low	Low	Low	Low	Low
Lunenburg	Low	Low	Low	Low	Low	Low	Low	Low
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Madison	Low	Low	Low	Low	Low	Low	Low	Low
Manassas, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Manassas Park, City of	Low	High	Low	Low	Low	Low	Low	Low
Martinsville, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Mathews	Low	Medium	Low	Low	Low	Low	Low	Low
Mecklenburg	Medium	Low	Low	Low	Low	Low	Low	Low
Middlesex	Low	Medium	Low	Low	Low	Low	Low	Low
Montgomery	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Nelson	Low	Low	Low	Low	Low	Low	Low	Low
New Kent	Low	Medium	Low	Low	Low	Low	Low	Low
Newport News, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Norfolk, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Northampton	Low	Medium	Low	Low	Low	Low	Low	Low
Northumberland	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Norton	Low	Medium-High	Low	Low	Low	Low	Low	Low
Nottoway	Low	Low	Low	Low	Low	Low	Low	Low
Orange	Medium	Medium	Low	Low	Low	Low	Low	Low
Page	Medium	Medium	Low	Low	Low	Low	Low	Low
Patrick	Medium	Low	Low	Low	Low	Low	Low	Low
Petersburg, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Pittsylvania	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Poquoson	Low	Medium-High	Low	Low	Low	Low	Low	Low
Portsmouth, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Powhatan	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince Edward	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince George	Medium	Medium	Low	Low	Low	Low	Low	Low
Prince William	High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Pulaski	Medium	Medium	Low	Low	Low	Low	Low	Low
Radford, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Rappahannock	Low	Low	Low	Low	Low	Low	Low	Low
Richmond	Low	Low	Low	Low	Low	Low	Low	Low
Richmond, City of	High	High	Low	Low	Low	Low	Low	Medium-

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
								Low
Roanoke	Medium-High	Medium-High	Low	Low	Low	Low	Medium	Medium-Low
Roanoke, City of	Medium-High	High	Low	Low	Low	Low	Low	Medium-Low
Rockbridge	Medium	Low	Low	Low	Low	Low	Low	Low
Rockingham	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Russell	Medium	Low	Low	Low	Low	Low	Low	Low
Salem, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Scott	Medium	Low	Low	Low	Low	Low	Low	Low
Shenandoah	Medium	Medium	Low	Low	Low	Low	Low	Low
Smyth	Medium	Medium	Low	Low	Low	Low	Low	Low
Southampton	Low	Low	Low	Low	Low	Low	Low	Low
Spotsylvania	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Stafford	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Staunton, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Suffolk	Medium-High	Medium	Low	Low	Low	Low	Low	Medium-Low
Surry	Low	Low	Low	Low	Low	Low	Low	Low
Sussex	Low	Low	Low	Low	Low	Low	Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Tazewell	Medium	Medium	Low	Low	Low	Low	Low	Low
Virginia Beach, City of	High	High	Low	Low	Low	Low	Low	Medium-Low
Warren	Medium	Medium	Low	Low	Low	Low	Medium	Medium-Low
Washington	Medium	Medium	Low	Low	Low	Low	Low	Low
Waynesboro, City of	Medium	Medium-High	Low	Low	Low	Low	Low	Medium-Low
Westmoreland	Low	Medium	Low	Low	Low	Low	Low	Low
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Low	Low	Low
Winchester, City of	Medium	High	Low	Low	Low	Low	Low	Medium-Low
Wise	Medium	Medium	Low	Low	Low	Low	Low	Low
Wythe	Medium	Medium	Low	Low	Low	Low	Low	Low
York	Medium-High	Medium-High	Low	Low	Low	Low	Low	Medium-Low

For the 2018 plan, the overall hazard ranking for wildfire is medium-low.

Table 3.18-7: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts are expected to be severe for the event area, and moderate for the outlying areas including smoke inhalation.
Health and Safety of Response Personnel	Localized impacts could be serious as local responders are working within the impacted area, if they live within the impacted area then they may be displaced for an extended period.
Continuity of Operations	Damage to facilities/personnel around the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Depending on the magnitude of the event, localized impact to facilities, residential properties, and infrastructure around the event could be severe.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be severe for the impacted areas, soil stability impacted, area likely to be vulnerable to landslides. Possible smoke and HAZMAT remediation needed.
Economic and Financial Condition	Local economic and financial conditions may be impacted for a long period depending on duration and geographical area of the event, as well as investigations around the cause of the fire.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient

Endnotes

[1] *HAZUS-MH Risk Assessment and User Group Series How-to-Guide: Using HAZUS-MH for Risk Assessment* (FEMA 433/August 2004)
[2] Virginia Department of Forestry. 2012 State of the Forest. Retrieved May 10, 2017, from http://www.dof.virginia.gov/infopubs/_sof/SOF-2012_pub.pdf
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[10] KRQE News 13. "Raton wildfire won't cut gas after all." June 15, 2011. http://www.krqe.com/dpp/weather/wildfires/raton-wildfire-cutting-off-gas-service
[11] Global Green House Warming: Climate Change and Wildfire. Retrieved May 11, 2017 from http://www.global-greenhouse-warming.com/climate-change-and-wildfires.html
[12] Virginia Department of Forestry. 2015 State of the Forest. Retrieved May 10, 2017, from http://www.dof.virginia.gov/infopubs/_sof/SOF-2015_pub.pdf

Section 3.19: Winter Weather



City of Alexandria
February 2010
Source: EPA Michael Reynolds

Description

The winter season brings a variety of natural hazards including blizzards, snowstorms, ice, sleet, freezing rain, and extremely cold temperatures. Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation.

Snow storms can amount to light flurries to blizzards with blinding wind driven snow. Sleet – raindrops that freeze into ice pellets before reaching the ground – usually bounces when hitting a surface and do not stick to objects; however, sleet can accumulate like snow and cause a hazard to motorists. Freezing rain is rain that falls onto a surface with a temperature below freezing, forming a glaze of ice. Even small accumulations of ice can cause a significant hazard, especially on power lines and trees. An ice storm occurs when freezing rain falls and freezes immediately upon impact. Communications and power can be disrupted for days, and even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

A freeze is weather marked by low temperatures, especially when below the freezing point (zero degrees Celsius or 32 degrees Fahrenheit). House fires and carbon monoxide poisoning are possible as people use supplemental heating devices (wood, kerosene, etc.) and fuel burning lanterns or candles for emergency lighting.

Each of these winter weather events can occur throughout the state, although the western and northern parts of the state experience winter weather much more frequently. For example, weather station data from 1960 to 2000 shows nearly all monitoring stations experiencing a day with 12 inches of snow. However, in southeast Virginia events approaching this magnitude may occur only once every decade.

Virginia's biggest winter weather threat comes from a storm pattern known as a Northeaster or Nor'easter. These large storms usually originate to the south, and travel northward along the Atlantic coast. Warm, moist air from the ocean combined with cold air from the north can produce significant snowstorms throughout the mid-Atlantic and northeast coastal states. Depending on the specifics of each storm, the event may result primarily in rain, snow, or some combination thereof. Strong winds also characterize Nor'easters, often resulting in coastal flooding and erosion. The combination of heavy frozen precipitation and strong winds is

destructive and often damaging to trees and utility lines. Nor'easters may occur from November through April, but are usually at their worst in January, February, and March.

Some of the historic winter weather extremes in Virginia include:

- Lowest temperature of -30°F, recorded on January 21, 1985 at the Mountain Lake Biological Station in Giles County.
- Greatest 1-day snowfall of 34 inches, recorded on February 6, 2010 at the Lincoln weather station near Purcellville, Virginia.
- Highest single storm snowfall of 48 inches, recorded January 6-7, 1996 at Big Meadows.
- Greatest monthly snowfall of 54 inches during February 1899 recorded in Warrenton.
- Greatest seasonal snowfall of 124.2 inches during the 1995-1996 winter season, recorded in Wise County. Major winter storms typically affect large areas of the nation. During the 1990s, winter storms in Virginia resulted in more localities qualifying for major disaster declarations than any other hazard.

Extreme Cold

Regardless of precipitation, excessively cold temperatures also pose occasional threats to the Commonwealth. While wind chill advisories are issued nearly every year, life-threatening excessive cold is a rare occurrence, and the impact of such events depends on the preparedness of individual households and heating fuel/energy providers.

Definitions of extreme cold can vary dramatically across the state and country. Jurisdictions in the southeastern part of the state that do not receive frequent winter weather might consider a day below 32ºF as extreme, while jurisdictions in the Blue Ridge or Piedmont area would have a different threshold for defining extreme cold.

The New River Valley Planning District Commission identified extreme cold as a high hazard. The Middle Peninsula and Thomas Jefferson Planning District Commissions both identified extreme cold as a low hazard. The remaining 18 local plans did not rank extreme cold. Section 3.6 includes the overall rankings for the local plans. Due to the limited impacts to population and infrastructure, this hazard was not analyzed in detail as part of this plan.

Historic Occurrence

To appreciate the history of winter weather in Virginia, it is useful to understand the measurement system used.

The Regional Snowfall Index (RSI) provides a useful methodology for classifying snowstorms based on societal impact. The RSI is an evolution of the Northeast Snowfall Impact Scale (NESIS) which the NCEI began producing in 2005. NESIS focuses on the impact of storms in

the Northeast, while the RSI divides the US into six easternmost climate regions (Northern Rockies and Plains, Upper Midwest, South, Ohio Valley, Northeast, and Southeast) and develops a separate index for each of those regions based on region-specific parameters and population impact considerations[1]. Virginia is part of the Southeast region. The RSI values range from 1 to 18+ or 'notable' to 'extreme'[2]. It is possible for Virginia to experience the entire range of the scale. Researchers at the NCEI have calculated the scores for high-impact storms dating back to the 1900s.

A few of the significant winter storms affecting Virginia in recent decades include the following:

- March 5-9, 1962: The Ash Wednesday Storm was a Nor'easter that brought heavy snowfall to interior portions of the state, as well as flooding and shoreline erosion. Snowfalls of 20 inches or more were reported in Harrisonburg, Lexington, Staunton, and in Rockingham County. Virginia Beach and Hampton experienced flooding, wind damage and erosion due to high waves.
- January 1977: The Bicentennial Winter was described as the coldest season seen on the East Coast since before the founding of the republic. The tidal Potomac froze solid enough that people could skate across it near the Memorial Bridge. January's average temperature was 25.4°F in Washington DC, the coldest since 1856. The prolonged cold wave led to oil and natural gas shortages.
- February 10-11, 1983: The Blizzard of 1983 blanketed a large portion of the state with deep snow. Accumulations between 15 and 20 inches were reported in Augusta County, Harrisonburg, Lexington, Rockbridge County, Lynchburg, Roanoke County, and Richmond. Strong winds caused even higher snowdrifts. The storm cost the state an estimated $9 million in snow removal. This storm scored an 11.946 on the southeast region RSI scale, which is described as a crippling event; the storm affected not only Virginia, but also many other Mid-Atlantic and Northeast states.
- March 13-14, 1993: The Storm of the Century affected nearly the entire East Coast, costing billions of dollars in damage and snow removal. Its effects in Virginia were less significant than other historic storms, but it affected more communities, ranging from the Chesapeake Bay through central Virginia, and was quite severe in Southwest Virginia. This storm is the second highest –ranked event on the southeast regions RSI scale at 20.572 on the southeast region RSI scale, which is described as an extreme event. (FEMA DR-3112).
- January-March 1994: The Ice Storms of 1994 coated portions of Virginia with 1 to 4 inches of ice, due to freezing rain and sleet. Approximately 10-20 percent of trees in some jurisdictions were damaged, as well as many utility lines. (FEMA DR-1014 and DR-1021).
- January 6-13, 1996: The Great Furlough Storm, so named due to a Congressional budget impasse, was one of the most widespread, heavy snowfalls in Virginia in recent times. Snow fell in excess of 10 inches throughout almost the entire state, with snowfalls in

excess of 20 inches throughout central and western Virginia. The event consisted of two back-to-back heavy snowfalls, leaving snow on the ground for an extended period. Eventual thawing combined with heavy rain caused severe flooding. (FEMA DR-1086).

- December 23, 1998: The Christmas Ice Storm struck central and southeast Virginia on Wednesday the 23rd and lasted until Christmas Day. Accumulations of up to an inch of ice brought down trees and power lines. Approximately 400,000 customers were without power on Christmas Eve, and some people remained without power for as many as ten days.
- January 23-26, 2000: This Nor'easter brought snowfalls between 5 and 20 inches to the eastern half of Virginia, which does not frequently receive such snow depths. Heavy winds created blizzard conditions and created snowdrifts between 4 and 5 feet in some areas. Significant flooding and erosion affected coastal areas including the Grandview area of Hampton. This event was rated a 7.229 on the southeast region RSI scale, or major. A subsequent storm with significant ice accumulations occurred on January 30, leading Governor Gilmore to declare a state of emergency. (FEMA DR-1318).
- February 13-17, 2003: The most significant storm of the 2003-04 winter season impacted most of the state. Three rounds of precipitation resulted in 20 to 36 inches of snow across far northern Virginia. This decreased to between 7 and 12 inches of snow and sleet in the central part of the state and to several inches of sleet and/or 1/4 to 1/2 inch of ice accretion in the south. A 24-hour snowfall of 16.7 inches at Ronald Reagan National Airport was the fifth highest on record. Flooding and mudslides occurred in Southwest and Northern Virginia because of this storm. This event scored a 5.933 on the southeast region RSI scale, described as significant. (FEMA DR-1458)
- February 11-12, 2004: A winter storm brought significant snow across to northern and central Virginia; accumulations in most of the state ranged from 5 to 8 inches. Northern Virginia and Washington DC received 10 to 15 inches. Nearly 300,000 customers in northern Virginia were without power due to downed trees and power lines.
- December 26, 2004: The Day after Christmas Ice and Winter Storm brought a narrow band of snowfall to Virginia's Eastern Shore and southeast Virginia. Snow depths of up to a foot accumulated in York County, Accomack County, Northampton County, Isle of Wright County, Newport News, and Poquoson.
- December 18-21, 2009: A nor'easter that formed over the Gulf of Mexico developed into a winter storm affecting much of the East Coast. This event was rated a 12.776 on the southeast region RSI scale, or crippling. This snowstorm resulted in a federal disaster declaration. Buchanan, Virginia reported 27 inches of snow on December 19, 2009. (FEMA DR-1874)
- February 4-7, 2010: A nor'easter affecting northern Virginia was rated an 8.103 on the southeast region RSI scale, or major. This snowstorm was a federally declared disaster.

The Lincoln weather station near Purcellville in Loudoun County reported 34 inches of snow on February 6, 2010.

- January 22-24, 2016: A severe winter storm and snowstorm, rated 7.66 on the RSI scale, or crippling. The storm is fourth on the list of historic storms ranked on the NESIS scale. This storm resulted in a federal disaster declaration. (FEMA DR-4262)

Risk Assessment

Probability

The probability of future winter weather events is usually determined empirically based on the historical frequency of occurrence of such events. The NCEI *Storm Events Database* records winter weather events and damages dating back to 1996, but it does not systematically document the magnitude or intensity of each event. Long-term weather station observation data provides more detailed information on event magnitude (as measured by snowfall depth, precipitation types, and temperature) but does not provide any information regarding historical impacts.

Other sources of information relating to winter weather climatology include the Southeast Regional Climate Center, the Oregon State University's PRISM Group, as well as a variety of other national, regional, and local organizations.

Rather than using existing climatology information, independent analyses of weather station data were performed to estimate the probability of specific winter weather occurrences. While some of the ready-to-use data sources may be sufficient for planning purposes, they are typically limited to certain standard climate normal products. In this plan, independent analyses were used to illustrate the usage of the raw weather station data and to stimulate interest in using weather station data for other purposes.

The winter weather analysis from the previous version of this plan has been retained, as it still presents a reasonable assessment of the relative probability of winter weather conditions across the state. While more recent raw data is available from the NCEI, the distribution format has changed, and the processing methods used to analyze the data will require modifications to produce similar analysis outputs in the future.

Using daily weather station data involves decisions about which weather stations to include in the analysis and how to handle data gaps. In deciding which weather stations to use, the location, period of record, and data variables reported are the key factors. Virginia stations with substantially complete data from 1960 through 2000 were chosen for this analysis. Small interruptions or gaps exist in these stations' data records, which may indicate periods when the station was not operational. Entire years with no data were removed from consideration when conducting the analyses in this report, but smaller data gaps were ignored. As a result, the

statistics generated from this data may slightly underestimate the frequency or intensity of winter weather phenomena. More involved techniques may improve this area of the analysis, if desired.
To assess the probability and intensity of winter storm events, weather station data was downloaded from the NCEI archives.[3] A selection of cooperative (COOP) weather stations operating between 1960 and 2000 was loaded into a Microsoft Access database to determine the annual frequency of occurrence of certain conditions. The daily station data variables relevant to this investigation include 24-hour snowfall depth, minimum temperature, and daily weather type codes.

In addition to the frequency and depth of snowfall, the effects of winter weather on Virginia's residents are particularly severe when winter storms bring freezing rain, sleet, and ice/snow mixtures. The broad network of COOP weather stations used to estimate snowfall frequency and depth does not provide sufficient information to identify these different types of precipitation. Precipitation type classifications have been recorded by a smaller set of weather stations for many years, which are located primarily at major airports around the state. These classifications, reported on an hourly and/or daily basis, can be used to identify the dominant type of precipitation during the period of observation.

Precipitation type data (DSI-3200 element DYSW) was downloaded and processed in a manner like the snowfall and temperature data. Many specific weather types were aggregated into simpler categories during this process. Only a few stations with substantially complete monitoring from 1984 through 2007 were considered for this investigation. The spatial distribution of the selected weather stations is not broad enough to depict the dominant weather types on a state-wide level. As noted previously in this section, these analyses are subject to some errors due to incomplete reporting; more thorough handling of gaps in the period of record could produce results that are more reliable. However, this simple analysis is sufficient for depicting the general nature of winter weather in Virginia. A more detailed analysis could also be performed using hourly precipitation type codes; but as with the daily codes, not all stations report this data.

Based on this analysis – which remains accurate in this plan update – winter weather will continue to be highly probable throughout Virginia. The northern and western parts of the state will receive winter weather almost annually, while the southern and southeastern portions will receive significant winter weather approximately once a decade.

Impact and Vulnerability

Winter weather vulnerability is a factor of individual, property, and societal elements. At the individual level, the potential for exposure to extreme cold, falling on ice-covered walkways, and automobile accidents is heightened during winter weather events. Potential personal property damage due to winter storms includes tree damage, water pipe breakage, structural failure due to

snow loads, and injury to livestock and other animals. Societal damages include disruption of utility distribution networks and transportation systems, as well as lost business and decreased productivity. The vulnerability to these individual, property, and societal damages varies based on specific factors; for example, proactive measures such as tree maintenance and utility system winterization can minimize property vulnerability. Localities experiencing winter storms on a regular basis are typically less vulnerable than localities that rarely experience winter weather, as they are typically better prepared and more experienced in managing the event and the response to it, as are the residents of the area.

The impacts of winter storms are primarily measured in terms of the financial cost associated with managing and recovering from them. The relationship between winter storm event magnitude and actual financial impact is difficult to model. Factors such as event timing and human perception complicate the relationship between overall magnitude and subsequent impact. Winter storms involving ice formation or accumulation are typically much more damaging than events consisting purely of snow.

The primary source of data providing some measurement of winter storm impacts is the NCEI *Storm Events Database*. This data dates to 1996, and is not always complete or consistent. A comprehensive analysis of weather station data, NCEI damages, and other relevant GIS data could possibly produce an intensity-damage relationship between winter weather occurrences and resultant damages. However, given the complexity of such an analysis, and the relatively short period for which NCEI has recorded winter storm damage estimates, this type of analysis has not been undertaken as part of this plan.

The Southeast Regional Climate Center released a technical paper from the University of Virginia Climatology Office in May of 1993 titled *Frequency of Weather Related Tree Damage in Virginia*. This report analyzed tree damage reported in NOAA's *Storm Data* publication from 1959-1991, noting damages due to a variety of weather events, including severe winter weather. Among other findings, the analysis found that while more snow events occurred in western and northern jurisdictions, tree damages were reported throughout the state[4].

The state and local agencies most often affected by winter storms include the Virginia Department of Transportation (VDOT), and in some cases, local public work departments. Roadway treatment operations often commence prior to the actual onset of a winter storm, and continue for as long as necessary in a prioritized manner. Theoretically, a database of historical response costs could provide some insight into winter storm impacts. However, since the public demand for roadway treatment and response is almost never fully met, such data on historical roadway treatment operations in response to winter storms may be more indicative of budget constraints than of relative storm magnitude.

Risk

While the annual probability of winter weather conditions can be estimated, data on the total financial impact of these events is not complete. Risk, strictly defined as probability multiplied by impact, cannot be fully estimated for winter storm due to the lack of accepted intensity-damage models for winter storm events. Therefore, projected annualized dollar losses cannot be estimated.

However, a rough estimate of financial impact can be developed based on the NCEI Storm Events database, although such an estimate is subject to the biases and inconsistencies present in that data. In the 20 years from 1996 through 2016, NCEI reports a statewide annual average of approximately $5.4 million per year. However, the available historic winter storm descriptions indicate that the total societal cost of these storms is much higher, as these estimates do not include road-clearing costs, lost productivity, energy costs, etc.

The winter weather frequency data shows a strong trend toward more winter weather occurring in areas at higher latitudes and at higher elevations. The mountainous western portion of the state and the furthest northern portions of the state experience winter weather more often and with greater severity. However, all portions of the state are subject to winter weather events. While the magnitude of damages from winter storm are perhaps not typically as great as extreme flooding or a severe earthquake, winter storms occur much more frequently and usually over broader areas. In addition, storm events with relatively low intensity can nevertheless cause significant impacts, especially in areas unaccustomed to such events.

Winter weather hazard zones were developed from the snowfall frequency results. This scoring system, as shown in Table 3.19-1, is used to identify facilities at risk, and to identify the jurisdictions exposed to the greatest winter weather hazards.

Table 3.19-1: Winter weather parameters

Winter Weather Hazard Zone	Average Annual Number of Days with at least 3 inches of snow
Low	<1.5 days
Medium-Low	1.5-2 days
Medium-High	2-3 days
High	>3

State Facility Risk

State facilities were intersected with the average annual number of days with at least three inches of snowfall layer. Annualized loss was not calculated due to the lack of established winter weather probabilities and lack of building specific data (including valuation).

The total number of facilities located in the potential damage zones is summarized in Table 3.19-2. Approximately 22 percent of the state facilitates are in an area with a high winter weather hazard, three or more days with more than three inches of snow.

Table 3.19-2: State Facilities at risk for Winter Weather

Winter Weather Hazard Zone	Number of State Facilities
Low	4,099
Medium-Low	2,304
Medium-High	3,637
High	2,763
Total	**12,803**

The results of this analysis indicate 2,763 buildings are in a high hazard zone for winter weather. Those 2,763 buildings can be divided between 78 different agencies in Virginia. The top five of those agencies have been listed in Table 3.19-3. The agencies listed represent approximately 8% of the buildings owned by the Commonwealth, almost 38 percent of the buildings that are within a high hazard zone, three or more days with more than three inches of snow.

Table 3.19-3: The top five agencies in a high hazard zone

Agency	Number of Buildings in High Hazard Zone
Virginia Polytechnic Institute and State University	749
James Madison University	191
University of Virginia at Wise	51
Woodrow Wilson Rehabilitation Center	38
Western State Hospital	20
Total	**1,049**

Critical Facility Risk

Risk for critical facilities was determined by the same parameters used above in state facilities; these results are presented in table 3.19-4. The critical facilities lacked data for building values, so these totals could not be determined. Annualized loss was not calculated due to the lack of established winter weather probabilities and lack of building specific data (including valuation).

Table 3.19-4: Critical facilities at risk for winter weather.

Winter Weather Risk	Law Enforcement	Transportation	Public Health	Emergency Response	Education	Total
Low	241	22	434	937	1,121	**2,755**
Medium-Low	81	9	77	372	239	**778**
Medium-High	172	12	365	902	1,192	**2,643**

Winter Weather Risk	Law Enforcement	Transportation	Public Health	Emergency Response	Education	Total
High	166	13	195	620	484	**1,478**
Total	**660**	**56**	**1,071**	**2,832**	**3,036**	**7,655**

Winter Weather Risk to Energy Pipelines

Winter weather may impact pipelines in one of two ways. First, ground motion due to frost heave can put pressure on brittle pipelines possibly resulting in breakage. Second, snow and ice accumulations may damage the control mechanisms that support pipeline operations, or may damage regional power or telecommunication systems necessary for routine pipeline operations.

Future Conditions Considerations

As the earth's climate changes, heavy seasonal snow years have begun to occur with greater frequency. According to NOAA's NCEI, the frequency of extreme snowstorms in the eastern US has increased over the past century, with approximately twice as many extreme snowstorms occurring in the last half of the 20th century as in the first half.

Conditions that influence snow storm severity including warmer ocean surface temperatures in the Atlantic. These increased temperatures can lead to exceptionally high amounts of moisture feeding into a storm, and contribute to storm intensification. Unusually high ocean surface temperatures in the Atlantic were a contributing factor to the February 2010 snowstorm that cripples Washington, DC in February 2010, dumping almost 18 inches of snow on the city. That storm was the fourth highest storm total for the city at that time.

Global ocean surface temperatures have increased at a rate of +.18 Fahrenheit each decade since 1950. Natural variability can affect surface ocean temperatures, but as global surface temperatures increase, the temperature is higher at any time than it would have been if the climate were not changing.

Some research has shown that increasing ocean surface temperature and reductions in Arctic sea ice may produce atmospheric circulation patterns that are favorable for winter storm development in the eastern US. Notably, a greater prevalence of high pressure blocking patterns over the North Atlantic that result in cold outbreaks in the eastern US, along with slow moving systems can further exacerbate the longevity and severity of a snow storm.

Studies have shown that natural variability associated with El Nino conditions has a strong relationship and influence on the incidence of severe snow storms in the eastern US. An analysis of 100 storms in six regions east of the Rocky Mountains found that severe snow storms are approximately twice as likely to occur in the eastern US – north and south – during years when a

moderate to strong El Nino is present as compared to years when more neutral conditions are present.[5]

Jurisdictional Risk

The hazard ranking for winter weather is based on damages reported in the NCEI *Storm Events Database* and a generalized geographic extent rating developed from the weather station data. Annualized crop and property damages received a low (1) ranking due to the small or infrequent amounts of damages as compared to the other hazards; injuries and fatalities were also ranked as low (1). These parameters in the winter weather risk assessment are detailed in Table 3.19-6, along with the total ranking. In general, the trends in low temperatures, snowfall, and other winter precipitation types all tend to indicate the same geographic areas experiencing more frequent winter weather. The highest winter weather risk is in western and northern Virginia, with generally decreasing risk towards the southeast.

The jurisdictions with a higher winter weather risk include:

- Clarke County
- Augusta County
- Frederick County
- Loudoun County
- Rockingham County
- Warren County
- City of Harrisonburg
- Highland County
- Page County
- Shenandoah County
- Fauquier County
- Rappahannock County
- Greene County
- City of Waynesboro
- City of Staunton
- City of Winchester
- Washington County
- Prince William County
- Fairfax County
- City of Roanoke
- Montgomery County
- City of Alexandria
- Arlington County
- Carroll County
- Wise County
- City of Norton
- Pulaski County
- Smyth County
- City of Galax
- Tazewell County
- City of Radford
- Craig County
- Wythe County

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

All 20 local plans assigned winter weather a hazard rank and gave a general description of winter weather and impacts for their region. Two plans discussed steep slopes and the impact of roads and infrastructure. Some plans developed relative risk hazard zones for snowfall and ice potential. Five plans summarized NCEI data that was used to derive annualized loss values (Table 3.19-5). The annualized loss values used by the local plans are similar to the summarized data used in the statewide ranking.

Table 3.19-5: Local plan winter weather annualized loss

PDC/Jurisdiction	Winter Weather Annualized Loss
Commonwealth RC (Virginia's Heartland)	$5,590
Central Shenandoah PDC	$5,715,666
Rappahannock-Rapidan RC	$167,8645
Richmond-Crater PDC	$40,011
West Piedmont PDC	$116,786

Comparison with Local Ranking

15 of the 20 local plans ranked winter weather as a high hazard; the remaining five ranked the hazard as medium.

The local plan ranking average was high for winter weather (section 3.6). The 2018 statewide analysis ranked winter storm as medium. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

Most local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases, overall development patterns were discussed in general. 16 of the 20 local plans cite their comprehensive plans for current and future land use changes (section 3.2). Although winter weather was considered high for half of the local plans no information was given to reflect changes in development in the hazard prone areas.

Table 3.19-6: Winter Weather Hazard Ranking Parameters

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Accomack	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Albemarle	Medium-High	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Alexandria, City of	Medium-High	High	Low	Low	Low	High	High	Medium
Alleghany	Low	Low	Low	Low	Low	Medium	Medium	Low
Amelia	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Amherst	Medium	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Appomattox	Low	Low	Low	Low	Low	Medium	Medium	Low
Arlington	High	High	Low	Low	Low	High	High	Medium
Augusta	Medium-High	Medium	Low	Low	Low	High	High	Medium
Bath	Low	Low	Low	Low	Low	Medium	Medium	Low
Bedford	Medium-High	Medium	Low	Low	Low	Medium-High	Medium-High	Medium
Bland	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Botetourt	Medium	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Bristol, City of	Low	Medium-High	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Brunswick	Medium	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Buchanan	Medium	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Buckingham	Low	Low	Low	Low	Low	Medium	Medium	Low
Buena Vista, City of	Low	Medium-High	Low	Low	Low	Medium	Medium	Medium-Low
Campbell	Medium	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Caroline	Medium	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Carroll	Medium	Medium	Low	Low	Low	High	High	Medium
Charles City	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Charlotte	Low	Low	Low	Low	Low	Medium	Medium	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Charlottesville, City of	Medium	High	Low	Low	Low	Medium	Medium	Medium-Low
Chesapeake, City of	High	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Chesterfield	High	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Clarke	Low	Medium	Low	Low	Low	High	High	Medium-Low
Colonial Heights, City of	Medium	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Covington, City of	Low	Medium-High	Low	Low	Low	Medium	Medium	Medium-Low
Craig	Low	Low	Low	Low	Low	High	High	Medium-Low
Culpeper	Medium	Medium	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Cumberland	Low	Low	Low	Low	Low	Medium	Medium	Low
Danville, City of	Medium	Medium-High	Low	Low	Low	Medium	Medium	Medium-Low
Dickenson	Low	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Dinwiddie	Medium	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Emporia	Low	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Essex	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Fairfax	High	High	Low	Low	Low	High	High	Medium
Fairfax, City of	Medium	High	Low	Low	Low	Medium-High	Medium-High	Medium
Falls Church, City of	Low	High	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Fauquier	Medium-High	Medium	Low	Low	Low	High	High	Medium
Floyd	Low	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Fluvanna	Medium	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Franklin	Medium	Medium	Low	Low	Low	Medium	Medium	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Franklin, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Frederick	Medium-High	Medium	Low	Low	Low	High	High	Medium
Fredericksburg, City of	Medium	High	Low	Low	Low	Medium-High	Medium-High	Medium
Galax, City of	Low	Medium-High	Low	Low	Low	High	High	Medium
Giles	Low	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Gloucester	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Goochland	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Grayson	Low	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Greene	Medium	Medium	Low	Low	Low	High	High	Medium
Greensville	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Halifax	Medium	Low	Low	Low	Low	Medium	Medium	Medium-Low
Hampton, City of	Medium-High	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Hanover	Medium-High	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Harrisonburg, City of	Medium	High	Low	Low	Low	High	High	Medium
Henrico	High	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Henry	Medium	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Highland	Low	Low	Low	Low	Low	High	High	Medium-Low
Hopewell, City of	Medium	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Isle of Wight	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
James City	Medium-High	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
King and Queen	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
King George	Medium	Medium	Low	Low	Low	Medium-High	Medium-High	Medium-Low
King William	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Lancaster	Low	Medium	Low	Low	Low	Medium-Low	Medium-Low	Low
Lee	Medium	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Lexington, City of	Low	High	Low	Low	Low	Medium	Medium	Medium-Low
Loudoun	High	Medium-High	Low	Low	Low	High	High	Medium
Louisa	Medium	Medium	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Lunenburg	Low	Low	Low	Low	Low	Medium	Medium	Low
Lynchburg, City of	Low	Medium-High	Low	Low	Low	Medium	Medium	Medium-Low
Madison	Low	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Manassas, City of	Medium	High	Low	Low	Low	Medium-High	Medium-High	Medium
Manassas Park, City of	Low	High	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Martinsville, City of	Low	Medium-High	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Mathews	Low	Medium	Low	Low	Low	Medium-Low	Medium-Low	Low
Mecklenburg	Medium	Low	Low	Low	Low	Medium	Medium	Medium-Low
Middlesex	Low	Medium	Low	Low	Low	Medium-Low	Medium-Low	Low
Montgomery	Medium-High	Medium	Low	Low	Low	High	High	Medium
Nelson	Low	Low	Low	Low	Low	Medium	Medium	Low
New Kent	Low	Medium	Low	Low	Low	Medium-Low	Medium-Low	Low
Newport News, City of	High	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Norfolk, City of	High	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Northampton	Low	Medium	Low	Low	Low	Medium-Low	Medium-Low	Low
Northumberland	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Norton	Low	Medium-High	Low	Low	Low	High	High	Medium

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Nottoway	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Orange	Medium	Medium	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Page	Medium	Medium	Low	Low	Low	High	High	Medium
Patrick	Medium	Low	Low	Low	Low	Medium	Medium	Medium-Low
Petersburg, City of	Medium	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Pittsylvania	Medium-High	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Poquoson	Low	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Portsmouth, City of	Medium-High	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Powhatan	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Prince Edward	Medium	Medium	Low	Low	Low	Medium	Medium	Medium-Low
Prince George	Medium	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Prince William	High	Medium-High	Low	Low	Low	High	High	Medium
Pulaski	Medium	Medium	Low	Low	Low	High	High	Medium
Radford, City of	Low	Medium-High	Low	Low	Low	High	High	Medium
Rappahannock	Low	Low	Low	Low	Low	High	High	Medium-Low
Richmond	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Richmond, City of	High	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Roanoke	Medium-High	Medium-High	Low	Low	Low	Medium	Medium	Medium-Low
Roanoke, City of	Medium-High	High	Low	Low	Low	High	High	Medium
Rockbridge	Medium	Low	Low	Low	Low	Medium	Medium	Medium-Low
Rockingham	Medium-High	Medium	Low	Low	Low	High	High	Medium
Russell	Medium	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low
Salem, City of	Medium	High	Low	Low	Low	Medium	Medium	Medium-Low
Scott	Medium	Low	Low	Low	Low	Medium-High	Medium-High	Medium-Low

Jurisdiction Name	Population Vulnerability	Population Density	Injuries & Fatalities	Property Damage	Crop Damage	Events	Geographic Extent	Total Risk Ranking
Shenandoah	Medium	Medium	Low	Low	Low	High	High	Medium
Smyth	Medium	Medium	Low	Low	Low	High	High	Medium
Southampton	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Spotsylvania	Medium-High	Medium	Low	Low	Low	Medium-High	Medium-High	Medium
Stafford	Medium-High	Medium-High	Low	Low	Low	Medium-High	Medium-High	Medium
Staunton, City of	Medium	Medium-High	Low	Low	Low	High	High	Medium
Suffolk	Medium-High	Medium	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Surry	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Sussex	Low	Low	Low	Low	Low	Medium-Low	Medium-Low	Low
Tazewell	Medium	Medium	Low	Low	Low	High	High	Medium
Virginia Beach, City of	High	High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Warren	Medium	Medium	Low	Low	Low	High	High	Medium
Washington	Medium	Medium	Low	Low	Low	High	High	Medium
Waynesboro, City of	Medium	Medium-High	Low	Low	Low	High	High	Medium
Westmoreland	Low	Medium	Low	Low	Low	Medium-Low	Medium-Low	Low
Williamsburg, City of	Low	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low
Winchester, City of	Medium	High	Low	Low	Low	High	High	Medium
Wise	Medium	Medium	Low	Low	Low	High	High	Medium
Wythe	Medium	Medium	Low	Low	Low	High	High	Medium
York	Medium-High	Medium-High	Low	Low	Low	Medium-Low	Medium-Low	Medium-Low

For the 2018 plan, the overall hazard ranking for winter weather is medium.

Table 3.19-7: Emergency Management Accreditation Program Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts are expected to be moderate to severe for affected areas and moderate to light for less impacted areas.
Health and Safety of Response Personnel	Personnel without proper cold weather clothing and equipment could expect severe impacts, and moderate impacts for those who have proper protection.
Continuity of Operations	Unlikely to execute Continuity of Operations Plan
Property, Facilities, and Infrastructure	Downed trees and power lines cause a moderate impact, building codes significantly reduces the impact to properties and facilities.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Damages to trees, downed trees can increase the risk for wildfires.
Economic and Financial Condition	Local economy may be impacted depending on type of event, local retailers may not be able to open for business.
Public Confidence in the Jurisdiction's Governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery time is not sufficient

Endnotes

[1] National Oceanic and Atmospheric Administration (NOAA). Regional Snowfall Index (RSI). Retrieved 04.11.17 from https://www.ncdc.noaa.gov/snow-and-ice/rsi/
[2] National Oceanic and Atmospheric Administration (NOAA). Regional Snowfall Index (RSI). Retrieved 04.11.17 from https://www.ncdc.noaa.gov/snow-and-ice/rsi/
[3] Currently hosted at: http://hurricane.ncdc.noaa.gov/CDO/cdo
[4] University of Virginia Climatology Office. "Frequency of Weather Related Tree Damage in the State of Virginia." Southeast Regional Climate Center Technical Paper Series, May 1993. Copy obtained from the University of Virginia Climatology Office. Print.
[5] National Centers for Environmental Information. "Climate change and extreme snow in the US." Retrieved 05.04.17 from https://www.ncdc.noaa.gov/news/climate-change-and-extreme-snow-us

Section 3.20: Summary

Summary of HIRA

Section 3.7 through 3.19 discussed the probability, impacts, and risks for each of the natural hazards that have been determined to have a significant impact on the population and infrastructure in the Commonwealth of Virginia. This final sub-section to the HIRA provides an overall assessment and summary of the individual hazard analyses.

GIS data for critical facilities and state facilities was used to determine risk for the infrastructure in Virginia. Section 3.4 fully describes the datasets that were used to create these two datasets that are referred to as critical facilities and states facilities.

Summary of Risk Assessment

Vulnerability of state and critical facilities is discussed in each of the hazard sub-sections in the HIRA. The individual hazard sections highlight the results of the analysis completed for this plan. Refer to the tables in these sections to determine what facilities are at greater risk for each hazard type; analysis is based on GIS intersections of the facility data with the geographic extent (GE) data. The data used for this analysis is available, through VDEM, for localities to use to update their plans. This information is ideal for determining structural mitigation strategies.

Critical Facility Risk

Most critical facilities are in medium or low hazard zones; less than a third are in high risk zones. The tables in each of the hazard specific hazard analysis sections can be used as a starting point for determining what types of mitigation actions would help to lower the vulnerability of critical facilities in the Commonwealth.

Section 3.4 describes the critical facility types and sources that were used for the vulnerability analysis in each of the hazard specific sections. Critical facilities point locations can be made available to localities through VDEM and can be used at the local level to determine if the spatial locations are correct. If acceptable, this analysis could be used to identify and recommend mitigation projects.

State Facility Risk

Like the critical facility analysis, state facilities were intersected with the GE for each hazard to determine which risk zone each building fell within. A summary of this data is available in each of the hazard sections in this report.

Overall Ranking Results

Section 3.6 describes the local plan ranking. As discussed, the local plan ranking compares agreeably to the new ranking that was developed for this report. Hazards that were considered negligible were included as textual descriptions in the major hazard sections. This includes erosion, extreme heat, and extreme cold. Analysis was not completed on human caused and hazardous materials since VDEM has separate plans that address these hazards in detail. Table 3.20-1 shows the overall ranking results of this plan.

To determine the overall hazard ranking, the total ranking values (RS value) for each of the hazards were separately averaged to determine what hazards should be considered the most significant in Virginia. Section 3.5 describes the ranking parameters that were used for this analysis.

Table 3.20-1: Overall hazard ranking for the Commonwealth of Virginia

High	Medium-High	Medium	Medium-Low	Low	Negligible
Flood	Tornado	Non-rotational wind Winter weather	Communicable disease Drought Earthquake Landslide Wildfire	Impoundment failure Karst (sinkholes) Land subsidence Solar storm/flare	Erosion Extreme heat Extreme cold

Note: Tsunami was removed for this plan update.

The individual hazard sections provide information and analysis tables for which jurisdictions are considered high risk areas. As stated multiple times in this section, this analysis is only representative of the NCEI data that was used. It is known that the time period of this data is small in comparison to the known historical events. For example, Hurricane Camille in 1969 is before the period of record kept on flooding and landslide, although both were incurred during that event. The data does not fully represent geological hazards but in the absence of better data NCEI was used to represent risk in Virginia. Currently Virginia Department of Forestry (VDOF) is the only geological agency to maintain a comprehensive database, though the Virginia Division of Geology and Mineral Resources (DGMR).

Estimating Potential Losses

The local hazard mitigation plans were reviewed to determine if the local plan loss estimates could be summarized to create statewide loss estimates. During the review it was noticed that some plans did not include complete loss estimates and others were highly variable in the methodology used. A summary of the local plan loss estimates for hurricane and flood is provided in Table 3.6-4 of section 3.6. The variability in the local loss estimates limits the ability to integrate them into statewide vulnerability and loss estimate. Ideally, future revisions to the local plans could follow a standard template for loss estimation that would allow the next revision of the state plan to seamlessly integrate the information from the local plans.

Rough estimates of annualized losses can be generated based on the NCEI *Storm Events Database*, which documents the damage costs associated with the various hazards. Supplemental annualized loss values for flooding, hurricane winds, and earthquake have also been derived from the other sources as described in each individual hazard section. NCEI did not include any historical information about damages due to any geologic hazard, and is not included in the loss estimates. Impoundment failure was not included as part of the hazard ranking due to lack of data. See the Flooding due to Impoundment Failure (Section 3.11) for more details.

Based on information from the NCEI database, the Commonwealth of Virginia can expect approximately **$116,337,686** in annualized damages due to all the hazards that impact Virginia. As discussed in Section 3.3 this data has limitations due to the amount of historical data available, and reporting of significant events.

Table 3.20-1 below illustrates the number of years of record for each hazard, total damages reported in 2016 dollars, and annualized loss values. Flooding and non-rotational wind make up approximately two-thirds of annualized damages. Based on this analysis, flood and non-rotational wind mitigation strategies should be a high priority for the Commonwealth.

The estimates given for annualized loss are only based on the hazard categories that were determined to be significant types in Virginia. Table 3.3-4 includes the NCEI categories that make up each of the established HIRA hazard types used in this analysis. A complete listing of the NCEI categories could yield annualized loss values significantly different from what is listed in Table 3.20-1.

Annualized Loss by Jurisdiction

The NCDC information used to generate Table 3.20-1 was also used as parameters in the hazard ranking. The hazard specific sections (3.7-3.19) include information regarding the annualized loss by jurisdiction. The ranking and risk parameter maps show the annualized property and crop damages, injuries and deaths, and events as established using NCEI data. The hazards that used

an established method for calculating annualized loss (flood, non-rotational winds, and earthquake) are explained in detail in those sections.

Annualized loss from VDOF is included in this table but was not used as the final annualized loss value for the Commonwealth. The differences in these two values are described in section 3.18 of this plan.

HAZUS-MH loss estimates are significantly higher than the NCDC estimates. This is to be expected as the HAZUS-MH results consider total direct economic losses including damage to structural, non-structural, building contents, inventory loss, relocation, income loss, rental loss and wage loss. NCEI loss estimates are solely based on the reported crop and property damage of past events. Although the numbers are different, each version of the annualized loss has hurricane winds as the highest loss hazard in the Commonwealth followed directly by flooding.

Table 3.20-2: Annualized loss values from NCEI and additional sources

Hazard Type	Timeframe	Years of Record	Number of Events	Property Damage	Crop Damage
Drought	1996-2016	20	2,252	$0	$527,365,000
Flood	1996-2016	20	5,419	$822,659,300	$70,758,500
Non-Rotational Wind	1950-2016	60	15,081	$1,518,539,187	$173,076,618
Tornado	1951-2016	65	848	$466,556,280	$2,626,500
Wildfire	1996-2016	20	46	$13,312,000	$1,587,000
Winter Storm	1996-2016	20	9,817	$61,349,900	$48,206,000
Debris Flow (Landslide)	1998-2016	18	4	$150,000	$0
Totals				**$2,882,566,667**	**$823,619,618**
Annualized Totals			**$ 116,337,686**	**$90,484,155**	**$25,853,531**

Comparison with Local Ranking

Table 3.6-2 of the Local Plan Incorporation section (Section 3.6) shows the average ranking for the local plans and statewide analysis. Three of the hazard categories that were addressed in the local plans were not considered in the state plan; these include hazardous materials, terrorism, and biological, radiological and epidemics. The COVEOP has separate plans that address human caused, radiological, and hazardous materials. Erosion, extreme heat, extreme cold, thunderstorm, lightning, hail, and tsunami have been included as textual descriptions in the major hazard sections. Of the hazards considered, the average rankings in local and state analysis are analogous.

Minor differences in the local and statewide ranking can be seen in Table 3.6-2 of section 3.6. Tornado received a medium ranking for the local plans but was elevated to a medium-high risk in the state plan. Winter weather received a ranking of high in the local plans but was reduced to a medium ranking for the state plan. Earthquake and landslide received a local plan average ranking of low and the statewide analysis resulted in a medium-low ranking. As discussed in section 3.1 and 3.6 detailed analysis was not completed for erosion, extreme heat, and extreme cold.

Comparison with Demographics and Land Use

Section 3.1 of this plan describes the general land use and population trends in Virginia over the last couple of decades. Four of the nine hazards were considered high risk in Northern Virginia communities; these areas are also experiencing a large surge in population and development.

South-central and southwest Virginia have been experiencing relatively low development, and in some extreme cases, population decline. These areas are often impacted by all of the hazards but because of the low population they have received a lower ranking.

Local hazard mitigation plans lacked detailed information about land use and future development planning. Generalized information about land use planning has been made at the State level but really should be evaluated locally. Land use planning, completed at local level, can reduce risk to the population and infrastructure by addressing the hazards that impact the jurisdiction. It is necessary for this to be done at the jurisdictional level since this is where planning, regulation, and taxation happen. For example, jurisdictions in the Ridge and Valley could evaluate karst zoning ordinances to limit development or population growth in areas known to have sinkhole development. Currently, revised land-use data is spotty depending on the sophistication of the local government and the need, will or ability to update information. A consistent land-use and population revision for the entire state at any specific time is going to remain a challenge that technological advances should overcome in the future. To that end, information from regional planning district commissions, many of whom provide GIS support to their member localities, will be critical to future HIRA revisions. VDEM mitigation staff will coordinate with localities

to ensure that future revisions of their local plans will be standardized and will can be uploaded and used in the next revision of the statewide hazard analysis.

Limitations of Data

The data sources used in this ranking/prioritization are varied in their degree of completeness, accuracy, precision, etc. The ability to accurately prioritize some of the hazards would be improved with better information about them. Further discussion on the data limitations and how the data was adapted for analysis is available in section 3.5 and in the hazard-specific sections (3.7 – 3.19).

Future Revisions to HIRA

An attempt was made to include the best available data for this revision of the hazard mitigation plan. Spatial data is constantly changing and efforts are being made to increase the accuracy of this data by many local, state and federal agencies. As this data is made available it will be used in revisions to this plan.

Using HIRA results in Mitigation Strategies

Data limitations have been noted throughout the HIRA section. Some of the issues can be resolved with closer coordination with federal, state, and local institutions. Data creation and management issues will take more time and effort to resolve and incorporate into revisions of this plan. The Advisory Committee and Working Group members are dedicated to the long-term vision of this plan and are currently working towards the next revision. Below is a summary of some of the issues that have been discussed throughout this section. Mitigation action items have been created to address these.

1. Incompatible data sets between state agencies that cannot be truly compared or joined together.
2. Lack of detailed, comprehensive information for all hazard occurrences and locations.
3. Inconsistencies in content between the local plans, resulting in incomplete or missing information helpful to analysis.

Disaster Mitigation Act of 2000

§201.4(c)(3)(ii): A discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including: and evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas; a discussion of State funding capabilities for hazard mitigation projects; and a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.

4.1 Statewide Capability Assessment

The following section has been updated by the Virginia Department of Emergency Management (VDEM), and related local, state, and federal agencies as a part of the 2018 update process. This section was reviewed, revised, and validated by both the COV SHMP Advisory Committee and Working Group. Changes in federal, state, and local capabilities are included, as well as information from local hazard mitigation plans.

A comprehensive capability assessment includes an examination of administrative, political, and financial support for the proposed actions. A listing of traditional mitigation and conservation programs available to fund some types of mitigation efforts follows. This is not a complete listing, but is intended to initiate discussion of potential funding and resource opportunities. As the plan focuses on mitigation of state facilities, funding may be available through capital improvement budgets that each agency submits as part of the biennial budgeting process tied to the legislature.

Presidential Preparedness Directive #8 (PPD-8) continues to impact hazard mitigation activities in the Commonwealth. PPD-8 is intended to strengthen both the security and the resilience of the US through preparation for the threats and hazards that pose the greatest risk to the security of the US. To that end, PPD-8 requires that a Threat Hazard Identification and Risk Assessment (THIRA) be developed to remain eligible for Emergency Management Program Grant (EMPG) funding. The Commonwealth THIRA informs this plan, and is maintained as a separate document and process. The Commonwealth's THIRA informed the update of this plan, but is not incorporated into this plan.

The Biggert-Waters Flood Insurance Reform Act of 2012 authorized significant implications on flood mitigation across the Commonwealth, including that NFIP policy owners of certain structures would have their annual flood insurance premiums increase at 25% a year until actuarial rates were reached. The Consolidated Appropriations Action of 2014 prohibited the implementation of many sections of Biggert-Waters, and resulted in the halting of certain rate increases while new legislation was developed to address rate increase concerns[1]. The Homeowner Flood Insurance Affordability Ac of 2014 (HFIAA) repealed certain provisions of Biggert-Waters. HFIAA restored grandfathering of structures, placed limits on certain rate increases, and applied surcharges to all policyholders to ensure the fiscal soundness of the National Flood Insurance Fund[2].

Additionally, the consolidation of three annual flood grant programs (Flood Mitigation Assistance, Repetitive Flood Claims, and Severe Repetitive Loss) into one grant program (Flood Mitigation Assistance) with annual appropriations to be determined by Congress was completed. Severe Repetitive Loss (SRL) and Repetitive Loss (RL) properties included in a single grant application receive reduced non-federal cost shares. This reduction in the required non-federal cost share provides an additional incentive to communities to seriously address their RL/SRL properties.

4.2 Pre-Disaster Mitigation Programs

Mitigation programs reduce the vulnerability of people, property, and natural resources to the destructive forces of natural events and human actions. Temporary measures are often implemented in emergency situations during response. Permanent measures use structural and non-structural approaches to reduce vulnerabilities to and risks from hazards.

The programs described in Table 4.1 were created by the US Congress and the Commonwealth to address specific natural hazards. *When adequately staffed and funded*, these programs are comprehensive and extremely effective in reducing the effects of natural hazards. However, during the past two decades of state and federal budget challenges, full funding and staffing of programs has been rare. Due to multiple disaster declarations since 2009, federal Hazard Mitigation Assistance (HMA) funds have been available; however, localities have had difficulties developing cost effective projects and/or coming up with the non-federal cost share to take advantage of these opportunities.

4.3 Post-Disaster Assistance under a Federal Disaster Declaration

The Stafford Act revision impacted several key disaster assistance programs. The Hazard Mitigation Grant Program (HMGP) provides grants to states, federally-recognized tribes, and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. In the Commonwealth, HMGP funding is derived from 15% of the total costs of eligible federal disaster assistance through the Public Assistance (PA) and Individual Assistance (IA) programs. This assistance is available for (but not limited to) reducing future property damage to critical, commercial, residential, and public buildings, public infrastructure, and utilities through structural mitigation, mitigation planning, and initiative projects.

The PA Program, which is also authorized by the Stafford Act provides financial grants to assist state, tribal, and local governments and certain private non-profit (PNP) entities with the response to and recovery from disasters. Specifically, the program aids with costs related to debris removal, emergency protective measures, and permanent restoration and repair/replacement of infrastructure. The federal share of these expenses typically cannot be less than 75% of eligible costs. The program also encourages protection from future damage by providing funding for eligible hazard mitigation measures during the recovery process. These eligible hazard mitigation measures are limited to damaged elements and facilities.

Since November 2009, the Commonwealth has received ten federal disaster declarations. According to FEMA's website, the following amount of PA grants have been obligated in Virginia[3]:

Table 4.1 Public Assistance Declarations

Disaster Number	Disaster Description	Obligated Funds (As of June 2017)
DR 1862	November 2009 Nor'easter	$7.7 Million
DR 1874	December 2009 Snow Storms	$22.8 Million
DR 1905	February 2010 Snow Storms	$27.8 Million
DR 4024	Hurricane Irene 2011	$57.3 Million
DR 4042	Mineral Earthquake 2011	$43.6 Million
DR 4045	Tropical Storm Lee 2011	$5.7 Million
DR 4072	Severe Storms (Derecho) 2012	$21.8 Million
DR 4092	Hurricane Sandy 2012	$10.4 Million

Table 4.1 Public Assistance Declarations		
Disaster Number	**Disaster Description**	**Obligated Funds (As of June 2017)**
DR 4262	Severe Winter Storms and Snowstorm 2016	$47.6 Million
DR 4291	Hurricane Matthew 2016	$11.9 Million

The IA Program aids people who have suffered disaster related damages or have certain other disaster related needs. The most typical forms of aid are rental assistance, home repair, and replacement of personal property. An IA declaration also provides help in a few other categories, such as unemployment assistance, legal assistance and, if requested and approved, crisis counseling.

The only direct form of assistance available to businesses is low interest loans through the Small Business Administration (SBA). Individuals are also able to apply for SBA loans to supplement any assistance they receive from IA. Since 2003, there have been three IA declarations in the Commonwealth of Virginia. According to FEMA's website, the following

Table 4.2 Individual Assistance Declarations		
Disaster Number	**Disaster Description**	**Obligated Funds (As of June 2017)**
DR 1491	Hurricane Isabel	$113 Million
DR 4042	Mineral Earthquake	$33.2 Million
DR 4291	Hurricane Matthew	$20.1 Million

amounts have been obligated for IA in Virginia[4]:

4.4 Funding Capabilities

There is never enough funding to adequately provide mitigation programs that will completely address properties at risk. It is intended that as awareness of hazard mitigation increases, due in part to implementation of this plan, funding can be increased through creative use of existing

programs as well as incorporation of mitigation into other non-traditional hazard mitigation programs. In the funding column within the program capacity analysis provided in Table 4-3, a check [✓] only means that funding is possible within the stated program, and does not indicate that funding is adequate, readily available, or has ever been applied to Commonwealth of Virginia disaster response, recovery or mitigation programs.

4.4.1 Traditional Funding Programs for Hazard Mitigation

Following development of the Commonwealth's initial hazard mitigation plan, an outreach program was initiated by VDEM to increase participation in traditional FEMA-Commonwealth mitigation grant programs. The funding programs listed below are the more common and most utilized programs in the Commonwealth.

A. Hazard Mitigation Assistance (HMA)

The HMA grant programs provide funding opportunities for pre- and post-disaster mitigation. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to natural hazards.

Hazard Mitigation Grant Program (HMGP)

Authorized by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (the Stafford Act), Title 42, United States Code (USC) 5170c. The primary purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is available during the repair, restoration, and reconstruction process following a disaster. HMGP is available, when authorized under a federal disaster declaration, in the areas of the Commonwealth requested by the Governor. The amount of HMGP funding available to the Recipient (the Commonwealth) is based upon the estimated total federal assistance provided by FEMA for disaster recovery under the federal disaster declaration.

Pre-Disaster Mitigation (PDM)

Authorized by Section 203 of the Stafford Act, 42 USC 5133. The Disaster Mitigation Act of 2000 (DMA2K) amended the Stafford Act by opening the PDM funding stream and requiring state and local hazard mitigation plans. The PDM program is intended to assist states, territories, tribal governments, and local communities to implement a sustained pre-disaster natural hazard mitigation program to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on

federal funding resulting from future disasters. The PDM Program was created to fund damage-reduction approaches, based on planning developed with three principles: (1) preventive actions must be decided at the local level; (2) private sector participation is vital; and (3) long-term efforts and investments in prevention measures are essential. Local governments, trough the Commonwealth's Planning Districts, periodically revise local hazard mitigation plans that enable them to compete for PDM funds once their local plan is approved. The federal share of a project for the PDM program is capped at 75% or $4 million, whichever is less.

Flood Mitigation Assistance (FMA)

Authorized by Section 1366 of the National Flood Insurance Act of 1968, as amended (NFIA), 42 USC 4104c, with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). This grant program is focused on those properties that, if mitigated, will benefit the National Flood Insurance Fund (NFIF) and NFIP policyholders. For the most part, the projects acquire, elevate, or relocate residential buildings that have a history of repetitive claims against the NFIF. All projects, including measures other than acquisition and elevation, must be cost effective and not have adverse environmental impacts. Localities wishing to apply for these funds must have an approved hazard mitigation plan. The amount of funding available is dependent on annual appropriations. FMA projects focus almost exclusively on Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties.

Federal funding is available for up to 75 percent of the eligible activity costs. FEMA may contribute up to 100 percent Federal cost share for SRL properties. An SRL property is a structure that:

(a) Is covered under a contract for flood insurance made available under the NFIP; and

(b) Has incurred flood related damage

i. For which four or more separate claims payments (includes building and contents) have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000, or

ii. For which at least two separate claims payments (includes only building) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

FEMA may contribute up to 90 percent Federal cost share for RL properties. An RL property is a structure covered by a contract for flood insurance made available under the NFIP that:

(a) Has incurred flood-related damage on two occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event; and
(b) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

B. Commonwealth Sum-Sufficient Match - HMGP

The HMGP program allows federal funding of up to 75%. The remaining 25% must be provided by non-federal funds. Historically, when available, the Commonwealth has provided up to 20% of the project costs, resulting in local match requirements of only 5%. Virginia's support of the program has made HMGP available to many local governments who otherwise could not provide the required 25% non-federal cost share. Presently, this funding cannot be used with any other HMA program.

C. Virginia Dam Safety, Flood Prevention, & Protection Assistance Fund

The Virginia Dam Safety, Flood Prevention, and Protection Assistance Fund was established to:

- Make matching grants and/or loans to local governments and to make loans to private entities owning dams for the correction of dam safety conditions (see category 1 projects description). State and federally-owned dams, or dams not regulated pursuant to the Dam Safety Act (§10.1-604 et seq. of the Code of Virginia) are ineligible.
- Make loans to a local government that has developed a low-interest loan program to provide loans or other incentives to facilitate the correction of dam deficiencies, as required by the Department of Conservation and Recreation (DCR), if the monies are to be used only for the program and that the dams to be repaired or upgraded are owned by private individuals or entities.
- Make matching grants to dam owners for the mapping of dam break inundation zones of dams regulated pursuant to the Dam Safety Act (§10.1-604 et seq. of the Code of Virginia) (see category 3 projects description).
- Make matching grants to dam owners for engineering for dam repairs.
- Make matching grants to dam owners for the development of emergency action plans.
- Make matching grants to dam owners to conduct incremental damage analysis in accordance with the Virginia Impounding Structure Regulations (4VAC50-20).

- Make matching grants or loans to any local government for assisting the local government in the development and implementation of flood prevention plans, studies, and mapping.
- Make matching grants or loans to any local government for assisting the local government in the development and implementation of flood prevention or protection projects, including damage mitigation and reduction activities (see category 6 projects description).
- Provide up to $50,000 annually for cost share with federal agencies in flood protection studies of statewide or regional significance. (For more information regarding this purpose of the fund, which is not addressed in this plan, contact DCR). The fund consists of monies appropriated by the General Assembly, assessments made on flood insurance premium income pursuant to §38.2-401.1 of the Code of Virginia, funds returned in the form of interest and loan principal by recipients of funding, income from the investment of monies contained in the fund, and other public and private funds eligible for deposit. The fund is permanent and non-reverting and is administered and managed by the Virginia Resources Authority (VRA) in cooperation with the Department of Conservation and Recreation (DCR).

The Director of DCR determines the type and amounts of funding available prior to each funding period, and will specify the categories that will be considered for loan and/or grant assistance. The Director is authorized to make expenditures in accordance with §10.1-603.16 et seq. and the terms of this guidance document following approval of applications from the Virginia Soil and Water Conservation Board.

D. Commonwealth of Virginia General Fund

Many of the structural mitigation projects detailed in this plan can be incorporated into capital improvement budgets that support renovation of existing structures or initiate new construction. Facilities managers have been active participants in the planning process and serve an integral role in seeking non-traditional mitigation funding to support structural mitigation projects.

E. Community Development and Block Grants (CDBG)

Often administered by the Commonwealth's Department of Housing and Community Development (DHCD), the program provides housing and commercial revitalization opportunities to many communities in the Commonwealth. CDBG has been effectively used in comprehensive recovery from major disasters such as Hurricanes Fran, Floyd and Isabel as well as severe storm and flooding events. Entitlement communities in Virginia administer their own CDBG funds separately from the Commonwealth's allocation.

Recently, CDBG has been used to assist after tornadoes in Glade Spring/Washington County (2011), Pulaski County and Town (2012), and Appomattox, Essex and Surry Counties (2016). The program also assisted the Town of Strasburg following Hurricane Sandy (2012). It is expected that CDBG will continue to be a critical funding source for housing mitigation programs, as it can typically be used as the non-federal portion of all HMA programs that require a match.

F. Increased Cost of Compliance (ICC)

If a house or business is damaged by a flood, individuals may be required to meet certain building requirements in their community to reduce future flood damage before repairs are made or rebuilding occurs. To help meet the costs of meeting those requirements, the National Flood Insurance Program (NFIP) includes Increased Cost of Compliance (ICC) coverage for all new and renewed Standard Flood Insurance Policies. Flood insurance policyholders in high-risk areas, also known as special flood hazard areas, can receive up to $30,000 to help pay the costs to bring their home or business into compliance with their community's floodplain ordinance. ICC assisted with recovery from Hurricane Isabel and will continue to be a critical funding source as the non-federal match for all HMA programs that require a match.

G. Homeland Security Grant Program (HSGP)

One of the core missions of the US Department of Homeland Security (DHS) is to enhance the ability of state, territory, local, and tribal governments to prevent, protect against, respond to and recover from terrorist attacks and other disasters. FEMA’s comprehensive suite of grant programs is an important part of the Administration’s larger, coordinated effort to strengthen homeland security preparedness.

H. Virginia Disaster Relief Fund

The DRF is a Commonwealth-managed relief fund established by Governor Bob McDonnell to financially help Virginia residents who are impacted by disasters. In August 2011, the governor made the fund a permanent part of the Commonwealth’s disaster relief tools, serving as a fund of last resort if other state, federal, and private aid was not available to assist with disaster recovery. Donations to the fund are accepted from individuals, companies, nonprofit organizations and faith-based groups. A state contribution of $600,000 in unspent general funds has been authorized by the governor.

Table 4.3 (following) uses the following phrases to describe the program’s support or relevance to mitigation. Some of the federal programs have not been used in Virginia due to timing, funding or appropriateness. The programs are listed are resources that have potential use in the state’s mitigation programs. As implementation of the plan continues, all relevant programs will

be explored as potential funding sources or technical support resources to assist successful funding and implementation of actions identified in the mitigation strategy.

Effectiveness Regarding Loss Reduction:

Support - programs, policies, funding or other assistance that helps implement mitigation.

Facilitate - programs, policies or technical assistance that assists implementation of mitigation measures.

Funding – programs that provide financial assistance for mitigation

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
Virginia Department of Emergency Management (VDEM)	Commonwealth of Virginia Emergency Operations Plan (COVEOP)	✓	✓		Directs emergency operations in response to any large-scale disaster impacting the Commonwealth. Assigns duties and responsibilities to agencies and support organizations for disaster preparedness, response, recovery and mitigation. Funding is achieved through appropriations in the biennial budget development process orchestrated by the Virginia General Assembly, and is supplemented in response to disaster declarations through sum-sufficient provisions that can provide state match to federal funding for individual assistance, public assistance and mitigation programs.	✓	✓	✓
Federal Emergency Management Agency (FEMA)	Hazard Mitigation Assistance Programs (HMA)	✓	✓	✓	HMGP, FMA, and PDM are HMA grant programs in which projects that reduce the long-term risk from natural hazards are eligible. The grant programs promote mitigation planning and structural projects, primarily aimed at the goal of reducing future flood risk.	✓	✓	
Federal Emergency Management Agency (FEMA)	Public Assistance Program	✓	✓	✓	To be eligible disaster recovery work performed on an eligible facility must: •Be required as the result of a major disaster event, •Be located within a designated disaster area, and •Be the legal responsibility of an eligible applicant. The following project categories are eligible for reimbursement: Debris Removal, Emergency Protective Measures, Roads and Bridges, Water Control Facilities, Buildings and Equipment, Utilities, Parks, Recreational, and other Facilities		✓	

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
Federal Emergency Management Agency (FEMA)	Individual and Housing Programs	✓	✓	✓	Federal law authorizes grants to disaster victims with disaster related expenses and needs that cannot be met through other available governmental disaster assistance programs. The federal share of a grant to an individual family under this program shall be equal to 75% of the actual cost of meeting such an expense or need and shall be made only on condition that the remaining 25% of such costs is paid to the individual or family from funds made available by the State. No individual or family shall receive any grant or grants under this program aggregating more than a maximum amount established by federal regulation with respect to any one major disaster.The Commonwealth maintains an Individual and Family Grant Program Administrative Plan, coordinates administration of the Individual and Family Grant Program through VDEM supervised by the State Coordinating Officer.		✓	
Virginia Department of Emergency Management (VDEM)	Virginia Disaster Relief Fund	✓	✓	✓	The Virginia DRF was established to provide financial assistance to Virginia residents who were impacted by the April 2011 tornados. Since that time, it has been expanded to aid Virginia residents for other disasters. Fund proceeds will be distributed to local long-term recovery groups, members of the Virginia VOAD and other non-profit and faith-based organizations as a grant. Many of these groups work directly with individuals and families following a disaster. The DRF benefits projects that include: repair or rebuilding of underinsured dwellings, transportation assistance, replacing essential household items, helping renters establish a new rental residence, and temporary living expenses while recovering from loss.		✓	

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
Federal Emergency Management Agency (FEMA)	Disaster Housing	✓	✓	✓	Temporary Housing Program: Residents within declared areas are eligible for temporary housing assistance. The FEMA Administrator or their designee determines that other circumstances necessitate temporary housing assistance. Home Repair Program: Home repairs may be provided to those eligible applicants who are owner-occupants of the primary residence to be made habitable, whose property can be made habitable by repairs to the essential living area within 30 days following feasibility determination. The FEMA Region III Director may extend this period.		✓	
US Department of Housing and Urban Development (HUD)	Mortgage Assistance from HUD's Federal Housing Administration	✓	✓	✓	For a declared disaster, FHA activates a mortgagee letter making a variety of insured loan programs available for disaster victims and putting into play use of special loan servicing and underwriting requirements.	✓		
Department of Housing and Community Development (DHCD)	Virginia Uniform Statewide Building Code which includes International Building Code	✓	✓	✓	Through the Virginia Uniform Statewide Building Code, buildings which are substantially damaged, i.e. repair costs are equal to or exceed 50% of the current appraised value, when repaired or reconstructed, are required to meet the code's floodproofing requirements for new buildings. This requirement is based on the provisions of the NFIP. The state floodplain management program, in partnership with VDEM and FEMA, has increased visibility of NFIP and building code requirements following disasters through aggressive contacts and educational programs directed to building officials, the insurance industry and contractors.	✓		

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
Federal Emergency Management Agency (FEMA)	Risk Map	✓	✓	✓	FEMA's Risk MAP (Mapping, Assessment, and Planning) is a 5-year initiative that builds on the recently completed Map Modernization program that updated and put in digital format much of the State's floodplain maps. Risk MAP has a broader and more holistic approach than Map Modernization, emphasizing not just the delivery of accurate maps but working with communities to understand the causes of flooding and help with mitigation strategies. Risk MAP is characterized by a full alignment of FEMA's programs - from discovering local needs, mapping with better base data, working with community representatives in assessing risk and vulnerability - with planning and mitigation considerations throughout.	✓		
Virginia Department of Conservation and Recreation (DCR)	Virginia Flood Risk Information System	✓	✓	✓	DCR, in collaboration with VIMS, has developed the Virginia Flood Risk Information System (VFRIS), an online tool that allows users to view and assess flood risk and help communities plan for resiliency. VFRIS includes all SFHAs in Virginia (taken from FEMA's NFHL), flood depth grids, the Limit of Moderate Wave Action, parcel boundaries, the ability to download flood insurance studies and flood risk reports, among other things	✓		
Virginia Department of Conservation and Recreation (DCR)	Community Rating System (CRS)	✓	✓	✓	The NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: 1. Reduce flood damage to insurable property; 2. Strengthen and support the insurance aspects of the NFIP, and	✓		

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
					3. Encourage a comprehensive approach to floodplain management Currently, 290 of the 323 communities in the Commonwealth participate in the NFIP. Additionally, 25 communities are participating in the Community Rating System, resulting in a total statewide savings of more than $4.8 million.			
Virginia Department of Conservation and Recreation (DCR)	Division of Dam Safety and Floodplain Management	✓	✓	✓	Coordinates all flood activities in the state, as well as the dam safety regulations. The division is responsible for the Dam Safety/Floodplain Management Grant program, as well as, the Commonwealth's Floodplain Management Plan.	✓	✓	
Federal Emergency Management Agency (FEMA)	National Dam Safety Program (NDSP):	✓	✓	✓	Grants to reduce the risks to life and property from dam failure, through the establishment and maintenance of an effective dam safety program.	✓		
US Department of Agriculture, Natural Resources Conservation Service (NRCS)	Emergency Watershed Protection	✓	✓	✓	When funding is allocated to a project, NRCS contracts the heavy construction work to local contractors, spurring creation of jobs. Typical projects funded under EWP include removing debris from waterways, protecting eroded stream banks, reseeding damaged areas, and in some cases, purchasing floodplain easements on eligible land. NRCS funds up to 75% of project costs, with local sponsors paying the remaining 25% in either cash or in-kind services.	✓		
US Department of Agriculture, Farm Service Agency	Supplemental Revenue Assistance Payment Program			✓	The SURE program provides cash payments to eligible producers who have incurred crop production losses or crop quality losses, or both.		✓	

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
(FSA)								
US Department of Agriculture, Food and Nutrition Service (FNS)	Disaster Assistance, Food Assistance	✓	✓	✓	The Food and Nutrition Service (FNS) coordinates with state, local and voluntary organizations to: Provide food for shelters and other mass feeding sites; Distribute food packages directly to households in need in limited situations; Issue emergency SNAP benefits; As part of the National Response Framework, FNS supplies food to disaster relief organizations such as the Red Cross and the Salvation Army for mass feeding or household distribution. State agencies notify USDA of the types and quantities of food that relief organizations need for emergency feeding operations. FNS also authorizes States to operate a Disaster Supplemental Nutrition Assistance Program (D-SNAP).			✓
US Department of Agriculture (Rural Development)	Housing and Community Facilities Loans	✓	✓	✓	Program assistance is provided in many ways, including direct or guaranteed loans, grants, technical assistance, research and educational materials. Loans are available for residential and facility development such as hospitals, roads, and bridges.		✓	
US Department of Agriculture Farm Service Agency (FSA)	Emergency Farm Loans	✓	✓	✓	Emergency Conservation program shares with agricultural producers the cost of rehabilitating eligible farmlands damaged by natural disaster. Farm Service Agency provides emergency loans to assist producers recover from production and physical losses due to drought, flooding, other natural disasters or quarantine. Natural Resources Conservation Service's Emergency Watershed Protection Program (EWP) provides emergency		✓	

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
					measures, including purchase of floodplain easements for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on the watershed. Food and Nutrition Service's Food Distribution division has the primary responsibility of supplying food to disaster relief organizations.			
US Department of Housing and Urban Development (HUD)	Community Development Block Grants	✓	✓	✓	Grants to entitlement communities. Preferred use of funding is for long-term needs but may be used for emergency response activities. Multi-family home mortgage insurance. Guaranteed/insured loans to finance the acquisition of proposed, under construction or existing single-family units. Homeowners are permitted to make a low down payments. For any person able to meet the cash investment, the mortgage payments and credit requirements. Special Mortgage Insurance for Low and Moderate Income Families, mortgage insurance for low and moderate-income families. The program can be used to finance rehabilitation of sub-standard properties. Anyone may apply; displaced households qualify for special terms. (This funding is separate from state CDBG funding, and is granted directly to the entitlement community. State funds cannot be used in entitlement areas.) Co-insurance: Joint mortgage insurance by the federal government and private lenders to facilitate homeownership financing everyone eligible for mortgage insurance under the full insurance programs may apply for co-insured loans to lenders approved by HUD as co-insurers. The co-insuring lender (any mortgage approved by FSA), based upon the characteristics of	✓	✓	

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
					the property and the credit qualifications of the borrower, determines whether to make the loan.			
NOAA National Weather Service (NWS)	Forecasts and Warnings	✓	✓	✓	Pubic forecasts and warnings of hazardous weather phenomena and floods, and training programs on disaster safety rules. Available to agencies and the public.	✓		
US Department of Energy	Disaster-related Power Outage				Implements emergency related functions under the Federal Response Plan.			✓
US Department of Homeland Security (DHS)	Urban Areas Security Initiative (UASI)	✓	✓	✓	A discretionary grant program that provides funding to metropolitan areas, including counties and mutual aid partners, to prepare for, prevent and respond to terrorist incidents.	✓		
US Department of Homeland Security (DHS)	Emergency Management Performance Grants (EMPG)	✓	✓	✓	The EMPG assists in the development, maintenance and improvement of state and local emergency management capabilities. These also include an Urban Search and Rescue and Interoperable Communications Grant.	✓		
VDEM, through its Volunteers and Donations Program with National and Virginia VOAD members.	Collection and Distribution of Donated goods	✓	✓		Support the establishment and management centers for receipts and distribution of donated goods such as food, clothing, furniture, medical supplies, building materials, cleaning supplies, bedding, utensils and tools. This is usually organized with a designated collection and/or distribution centers.		✓	

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
DBHDS, Department of Social Services, DCJS, and VDEM through partnership with National and Virginia VOAD.	Behavioral health, crisis first aid, emotional care	✓	✓		Crisis intervention counseling designed to assist disasters survivors and responders in coping with their situation to avoid serious psychological impairment.		✓	
Department of Agriculture and Consumer Services, and VDEM, through its partnership with National and Virginia VOAD.	Solidly frozen and/or non-perishable	✓	✓	✓	Food can be provided to disaster survivors and workers in several ways: 1. Direct provision of food stocks donated by individuals and groups to disaster survivors through distribution centers as described above. 2. Direct grants for food purchase or food stamp allotments (through section 409) provided to disaster survivors (described earlier in the Federal Assistance section). 3. Meals provided at or from feeding centers by mobile kitchens and/or portable canteens 4. Through section 410, provision of food stocks for emergency mass feeding or distribution to an area suffering a major disaster or emergency. In large scale disasters, FEMA will act as main agent in distribution of food.		✓	
VDEM, through its Volunteers and Donations Program, Virginia Guard, AmeriCorps, Others	Personnel	✓	✓	✓	Provision of personnel to supplement the labor necessary to respond to emergency disaster events, especially for clean-up and damaged home repair.		✓	✓

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
Department of Health, VDEM, State Police, Virginia Guard, ARC, Medical Examiner's Office	Medical Assistance			✓	Professional medical aid in the treatment of disaster victims, prevention or control of disease and handling and identification of persons killed during the event.			✓
VDEM, through its partnership with National and Virginia VOAD, Department of Housing and Community Development, Department of Health, AmeriCorps, NGOs	Repair of Houses	✓	✓	✓	Aid to homeowners to repair their homes in the absence of or to supplement FEMA's Individual Assistance Program. The ability of the listed agencies to aid may vary for each event and may be tied to the income level and demonstrated need of each recipient.		✓	
Local governments, Local governments' EOP's partners and/or State Shelter plan.	Shelter	✓	✓	✓	Establishment of shelters to protect the lives and health of persons forced to evacuate their homes due to an emergency or disaster occurs on a local, as needed basis. Shelters are short-term facilities (a few days to one week); families are returned to their homes or are placed in temporary housing locations as quickly as possible. Shelter locations are pre-designated in local Emergency Operations Plans.	✓		

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
Department of Forestry (DOF)	Forest Protection Program	✓	✓	✓	The department provides training and equipment to local fire departments that fight brush and forest fires. A network of dry hydrants throughout the state to supplement water sources such as rivers, reservoirs, lakes and ponds. An aggressive woodland homes wildfire prevention program is also managed. The agency also has a nationally credentialed incident management team which can provide planning and logistical support as well as incident command and control to support recovery and mitigation activities.	✓	✓	✓
Federal Bureau of Investigation (FBI)	Disaster Squad	✓	✓	✓	Fingerprint identification of disaster victims for any authorized state or local law enforcement agency.			✓
Virginia Department of Health (DOH)	Emergency Health Assistance	✓	✓	✓	Public Readiness and Emergency Preparedness Act Commonwealth: Code of Virginia Statutes and Corresponding Authorities during Mass Countermeasure Dispensing Event; Code of Virginia Statutes and Corresponding Authorities for Disease Surveillance, Investigation & Control in Virginia; Code of Virginia Statutes Relating to Other Significant Public Health Issues; Virginia Laws Governing Medical Examiner Notification and Jurisdiction; Virginia Administrative Code and Corresponding Authority Funding: HHS PHEP Cooperative Agreement administered by the Centers for Disease Control and Prevention (CDC); Hospital Preparedness Program Cooperative Agreement administered by the Office of the Assistant Secretary for Preparedness and Response (ASPR) Public Health & Healthcare Preparedness Capabilities: Community Preparedness; Community Recovery; Emergency Operations Coordination; Emergency Public Information & Warning; Fatality Management;	✓	✓	✓

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
					Information Sharing; Mass Care; Medical Countermeasure Dispensing; Medical Materiel Management & Distribution; Medical Surge; Non-Pharmaceutical Interventions; Public Health Laboratory Testing; Public Health Surveillance & Epidemiological Investigation; Responder Safety & Health; Volunteer Management. Healthcare Preparedness Capabilities: Foundation for Health Care & Medical Readiness; Health Care & Medical Response Coordination; Continuity of Health Care Service Delivery; and Medical Surge			
US Army Corps of Engineers (USACE)	Public Law 84-99 - Flood Control and Coastal Emergency Act	✓	✓	✓	USACE has authority for emergency management activities, including disaster preparedness, advanced measures, emergency operations (flood response and post-flood response), rehabilitation of flood control works threatened or destroyed by flood, protection or repair of federally authorized shore protective works threatened or damaged by coastal storm, and provisions of emergency water due to drought or contaminated source. Depending on the type of support, funds may be 100% federal, cost-shared, or on a reimbursable basis.	✓	✓	✓
US Army Corps of Engineers (USACE)	Public Law 93-288 - Robert T. Stafford Act	✓	✓		USACE assists the Department of Homeland Security and FEMA on a reimbursable basis by coordinating and organizing public works and engineering related support. Typical Emergency Support Function # 3 assistance includes mission assignments for the following: needs assessments, temporary power, ice and water, debris management, emergency infrastructure assessments, critical public facility restorations, demolition/structural stabilization, and technical assistance.		✓	

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
US Army Corps of Engineers (USACE)	Department of Defense Directive 3025.18 - Defense Support of Civil Authorities	✓	✓		This directive allows USACE to take immediate action in response to a request for assistance from a civil authority, under imminently serious conditions and if time does not permit approval from higher authority, USACE may provide an immediate response by temporarily employing the resources under their control, subject to any supplemental direction provided by higher headquarters, to save lives, prevent human suffering, or mitigate great property damage within the US. Support provided under immediate response authority should be provided on a cost-reimbursable basis, where appropriate or legally required, but will not be delayed or denied based on the inability or unwillingness of the requester to make a commitment to reimburse the Department of Defense.			✓
US Army Corps of Engineers (USACE)	Rivers and Harbors Act of 1899, Sections 15, 19, and 20, as amended	✓	✓	✓	USACE has the authority in an emergency to remove sunken vessels or similar obstructions from navigation channels in accordance with current regulations and guidance.			✓
US Army Corps of Engineers (USACE)	Rehabilitation and Inspection Program	✓	✓	✓	Public Law 84-99 gives USACE the authority for the inspection and rehabilitation of federal and non-federal flood risk management projects. Eligible projects can receive flood-fight assistance during a flood event and rehabilitation/repair assistance after getting damaged from a flood.		✓	✓
US Army Corps of Engineers (USACE)	Inspection of Completed Works Program	✓	✓		As an operations and maintenance program within the Rehabilitation and Inspection Program, provides for the periodic inspection of active federal flood risk management projects to determine if the project is being maintained in accordance with USACE criteria.	✓		

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
US Army Corps of Engineers (USACE)	Levee Safety Program and Dam Safety Program	✓	✓	✓	USACE developed and maintains the online National Levee Database and National Inventory of Dams available to the public to help communicate risk.	✓		
US Army Corps of Engineers (USACE)	Silver Jackets Program	✓	✓	✓	A USACE program that includes individual state and federal participation that leverages multiple programs and perspectives to help solve water resources problems at the state and local level. Federal participation typically includes USACE, FEMA, National Weather Service, US Geological Survey, National Resources Conservation Service, etc.	✓		
US Army Corps of Engineers (USACE)	Floodplain Management Services Program	✓	✓	✓	Under Section 206 of the 1960 Flood Control Act (PL 86-645) as amended, upon request, floodplain management technical assistance and general planning guidance can be provided to state and local governments, Native American Indian tribes, and other non-federal public agencies without charge. Program services also are offered to non-water resource federal agencies and to the private sector on a 100% cost recovery basis.	✓		
US Army Corps of Engineers (USACE)	Planning Assistance to the States Program	✓	✓	✓	Under Section 22 of the Water Resources Development Act of 1974 (Public Law 93-251), as amended by Section 205 of the 1992 WRDA, USACE can assist states, Native American Indian tribes, local governments, or other non-federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. Studies are cost-shared 50/50 between the federal government and non-federal sponsor (may include 100% work in kind) up to $500,000 annually. Typically, individual studies, of which there may be more than one	✓		

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
					per state or tribe per year, generally cost $25,000 to $75,000.			
US Army Corps of Engineers (USACE)	Continuing Authorities Program	✓	✓	✓	Congress has provided USACE with a number of standing authorities to study, design, and construct small scale (less than $10 million) water resource projects for various purposes without additional project specific congressional authorization. The sponsoring agency may be a state, county, city, tribe, or other group and must cost share in the project. Projects can include streambank and shoreline protection, flood risk management, navigation improvements, beneficial uses of dredged material, aquatic ecosystem restoration, and USACE project modifications for improvement to the environment. Cost-sharing for study and project costs can vary by business line.	✓		
US Army Corps of Engineers (USACE)	General Investigations Program	✓	✓	✓	Congress can authorize USACE to study, design, and construct major flood risk management, navigation, and ecosystem restoration projects that may cost more than $10 million. A feasibility study is cost-shared 50/50 between the federal government and non-federal sponsor, where the cost-sharing for other project costs can vary by business line.	✓		
Virginia Department of Historic Resources (DHR)	State Historic Preservation Office	✓	✓	✓	DHR, as the SHPO in Virginia, provides information and guidance to private and public historic property owners/managers regarding the protection, preservation, and repair/mitigation of historic buildings, structures, archaeological sites, and other culturally significant assets. DHR reviews and comments on state and federal projects that are subject to the State	✓	✓	✓

Table 4.3 – Recovery and Mitigation Programs								
Agency(s)	Programs, Plans, Policies, Regulations, Funding and Practices	Effects of Loss Reduction			Description	Pre-Disaster	Post Disaster	Emergency Response
		Support	Facilitate	Funding				
					Environmental Review Act, Section 106 of the National Historic Preservation Act, and other applicable state and federal laws and regulations. Funding is available for archeological sites that are endangered by erosion through DHR's Threatened Sites Program.			

4.5 Federal Agencies & Programs

After each declared disaster, federal resources that may support recovery are identified. Some federal programs can be accessed in an ongoing capacity to support local initiatives. As with local and state programs, these programs were in the background of the development of this plan, but were not specifically integrated into the final *Commonwealth of Virginia Hazard Mitigation Plan* because the plan primarily addresses state facilities determined to be at risk following analysis of vulnerability of state facilities to natural hazards. As implementation of the plan ensues, every opportunity to integrate existing federal programs into hazard mitigation will be explored.

For the 2018 update, a review of all federal programs that could assist in implementation hazard mitigation initiatives was undertaken. The following list of federal programs is intended to focus on those that are most applicable to the hazards that have occurred recently in Virginia.

Federal Emergency Management Agency (FEMA). As the nation's emergency management agency, FEMA's programs focus mainly on supporting state and local initiatives that will reduce the impacts of disasters. The programs provide technical assistance, regulatory standards and financial assistance. Some programs are activated only after a disaster is declared; others are ongoing.

Response & Recovery – Public Assistance (PA). Immediately following the declaration of a major disaster, FEMA and state-implement procedures to assess damage, estimate the cost of restoration, and allocate funds for recovery. Public Assistance program focuses on restoration of certain non-profit and public buildings, public utility and transportation infrastructure that covers a portion of the costs to respond and recover from the event. Under certain circumstances, mitigation measures can be factored into recovery of public buildings and facilities to minimize the potential for future losses from comparable events through use of the 406 program. Use of this program to strengthen structures impacted by disasters as part of the repair and recovery process will be pursued as disasters occur that provide federal Public Assistance funding for eligible structures. VDEM is responsible for coordinating response and recovery efforts with FEMA and local jurisdictions.

Response & Recovery – Individual Assistance (IA). Implemented jointly immediately following a major disaster declaration for events which impacts citizens, the IA program provides funds for temporary housing, basic housing repairs, and replacement of essential household items. IA is available directly to citizens who were impacted by the declared event in a declared jurisdiction.

Response & Recovery – Hazard Mitigation Grant Program (HMGP). VDEM manages this program, and project applications are required to be submitted to FEMA within a year of the federal disaster declaration. HMGP can fund projects such as the development/revision of state, local, and university hazard mitigation plans. HMGP can also fund projects to mitigate risk such as elevations, acquisition and demolitions, acquisition and relocations, minor localized flood control projects, infrastructure retrofits, floodproofing projects, wildfire mitigation, and safe room construction. HMGP can also fund initiative projects such as emergency generator quick connects, emergency generators, warning systems, GIS that supports mitigation, and outreach and education materials.

National Flood Insurance Program (NFIP). The NFIP offers flood insurance to property owners with insurable assets located in jurisdictions that adopt and enforce certain provisions that will help to minimize future flood losses. The measures apply to all activities proposed within special flood hazard areas that are designated on maps provided by FEMA. All development must be designed and constructed to withstand damage (from water and wind-related hazards) and must not create any adverse impacts on other properties. The single most effective measure (other than building outside of flood-prone areas) is to remove structures from the flood hazard area, either through acquisition or relocation.

RISK Map and Map Modernization. The vision for Risk MAP is to work collaboratively with state, local, and Tribal entities to deliver quality data that increases public awareness and leads to action that reduces risk to life and property. It also aims to foster informed risk management decisions and actions to mitigate risk through a consistent risk-based approach to assessing potential vulnerability and losses. By analyzing and depicting flood risk, communities and the American public can better understand their risk and make informed decisions to reduce their vulnerability.

Map Modernization transformed most the flood hazard mapping inventory to 21st century digital technology and restored confidence in the reliability of floodplain boundaries, while making updates to the underlying engineering data.

Cooperating Technical Partners (CTP). With over 20,000 communities in the NFIP, maintaining current maps is a daunting task. The map modernization effort is a collaborative process which spans all levels of government as well as a multitude of other organizations. This collaborative process results in partnerships among state,

regional, and local stakeholders. The Commonwealth participates in the Map Modernization initiative as a CTP.

Community Rating System (CRS). The CRS is an incentive program that rewards communities that exceed NFIP regulations in ways that reduce damage and improve safety. The incentive is a reduction in the cost of flood insurance premiums. Communities must apply, annually certify their programs, and undergo periodic audits. In Virginia, 25 communities participate in the CRS, resulting in flood insurance premium discounts of up to 20% for policyholders in their communities.

National Earthquake Hazard Reduction Program (NEHRP). The National Earthquake Hazards Reduction Program (NEHRP) was established by Congress when it passed the Earthquake Hazards Reduction Act of 1977, Public Law (PL) 95–124. At the time of its creation, Congress' stated purpose for NEHRP was 'to reduce the risks of life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards reduction program.' In establishing NEHRP, Congress recognized that earthquake-related losses could be reduced through improved design and construction methods and practices, land use controls and redevelopment, prediction techniques and early-warning systems, coordinated emergency preparedness plans, and public education and involvement programs.

National Hurricane Program (NHP). FEMA funding is provided to hurricane-prone states to establish, enhance and maintain basic levels of preparedness and mitigation capabilities, to promote effective mitigation measures, to conduct hazard identification and evacuation studies, to conduct post-storm analyses of mitigation measures, to conduct training, and to promote public awareness and education of hurricane safety and preparedness. The Commonwealth's participation is coordinated through the Preparedness Division at VDEM.

National Dam Safety Program (NDSP). FEMA coordinates the NDSP among federal agencies and state partners. In addition to maintaining a dam inventory, encouraging research, and promoting the implementation of state programs, the program also provides training and funds. Virginia's participation is coordinated with the Division of Dam Safety and Floodplain Management at DCR.

Virginia Flood Risk Information System (VFRIS). VFRIS is a collaboration between the Department of Conservation and Recreation and the Virginia Institute of

Marine Science's Center for Coastal Resources Management. The VFRIS is an online tool that allows users to view and assess flood risk and help communities plan for resiliency. VFRIS includes all SFHAs in Virginia (taken from FEMA's NFHL), flood depth grids, the Limit of Moderate Wave Action, parcel boundaries, the ability to download flood insurance studies and flood risk reports, among other things.

Dam Break Early Warning System. This is a state-wide system that will significantly improve public safety for residents that live downstream of over 600 high and significant hazard dams and has been shown to reduce fatalities from dam failures. The system is a real time, web-based system that monitors live feeds from the NWS, NOAA, NRCS, USGS, compares rainfall and stream data against pre-set thresholds and triggers alerts to notify dam owners and emergency responders of potential dam breaks. This program is coordinated through DCR.

Hazards US (HAZUS-MH™). HAZUS is a modeling program that utilizes a set of GIS-based tools that help estimate losses associated with earthquakes, floods, tsunamis, and wind. Developed in partnership with the National Institutes for Building Safety, HAZUS can be used to model event scenarios useful to compare risks between regions as well as evaluate effects of certain mitigation measures. Each state receives a copy of the software and certain baseline data. Recent improvements were made in the quality of data that characterize building types and locations, significantly improving analysis results. HAZUS was utilized within this plan update for the hurricane wind and earthquake modules.

US Department of Housing and Urban Development (HUD). HUD programs are administered through the Virginia Department of Housing and Community Development (DHCD) and local entitlement communities and offer several programs to support local efforts to address hazards and implement mitigation measures. The program can be used to minimize flood hazards:

Community Development Block Grant (CDBG). The CDBG program works to ensure decent affordable housing, to provide services to the most vulnerable in communities,

and to create jobs through the expansion and retention of businesses. CDBG is an important tool for helping local governments tackle serious challenges facing communities. The CDBG program has made a difference in the lives of millions of people and their communities across the nation. CDBG funds are routinely used in disaster-impacted areas for repair, elevation and acquisition/demolition of damaged structures, particularly citizens that qualify for the HMGP program.

Following Hurricane Isabel, a special CDBG congressional funding allotment was targeted to communities where HGMP funds could not fully address mitigation needs. In Henry County, a drainage improvement project was funded through HMGP with the non-federal cost share paid through CDBG. This is an example of coordination between CDBG and FEMA-VDEM funding to assist disaster recovery. At the state level, DHCD typically retains a limited amount of funding to be used for Urgent Needs funding.

US Department of Commerce, Economic Development Administration (EDA). EDA supports economic recovery strategies, in part by providing cost-shared funds for planning and technical assistance, emergency infrastructure grants, construction grants and a Revolving Loan Fund to assist communities and quasi-public entities such as local development corporations and public or private non-profit organizations. EDA funds have been used to retrofit or relocate public water supply or wastewater treatment facilities. After disasters, some communities use EDA long-term recovery funding to help businesses move to safer locations.

US Army Corps of Engineers. Within Virginia, USACE civil works projects for flood risk management, ecosystem restoration, and navigation activities and support are based on river basin watershed boundaries. The following five USACE District offices, including river basins, can provide assistance in Virginia:

- Baltimore District – Potomac and Shenandoah River Basins
- Huntington District – New and Big Sandy River Basins
- Wilmington District – Roanoke River Basin
- Nashville District – Tennessee River Basin
- Norfolk District – Chowan, James, Rappahannock, and York River Basins, Chesapeake Bay, and small coastal basins

For regulatory permitting activities, the Norfolk District oversees the entire state, but also coordinates with the other four USACE Districts as needed. In addition to the main office in Norfolk, regional field offices are located around the state to provide regulatory assistance.

For military work, the Norfolk District supports Army and Air Force installations within the state, outside of the Military District of Washington, with engineering, construction and project management services. The Norfolk District handles major design and construction efforts for nine installations: Arlington National Cemetery, Defense Supply Center Richmond, Fort A.P. Hill, Fort Lee, Fort Pickett, the National Ground Intelligence Center, Radford Ammunition Plant and Joint Base Langley-Eustis. The Baltimore District provides installation services and support to military members, civilians, retirees and their families at Fort Myer and Henderson Hall in

Virginia. USACE can also provide services to other federal customers under its Interagency and International Service Program.

Throughout Virginia, the Norfolk District's Real Estate office also manages timber harvests and sales on all Army installations, acquires and manages leases for housing for members of all branches of the armed services, provides support for privatization of Army Family Housing on Army installations, and plans, leases, and manages US Armed Forces Recruiting Centers.
The following support implementation of hazard mitigation initiatives; those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study:

Flood Control and Coastal Emergency Act (PL 84-99). USACE also has authority under Public Law (PL) 84-99, Flood Control and Coastal Emergencies (FCCE) (33 U.S.C. 701n) (69 Stat. 186) for emergency management activities. Under PL 84-99, the Chief of Engineers, acting for the Secretary of the Army, is authorized to undertake activities including disaster preparedness, advance measures, emergency operations (Flood Response and Post Flood Response), rehabilitation of flood control works threatened or destroyed by flood, protection or repair of federally authorized shore protective works threatened or damaged by coastal storm, and provisions of emergency water due to drought or contaminated source.

- Preparedness: The Flood Control and Coastal Emergency Act established an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for USACE emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with Local, State and Federal agencies.
- Response Activities: PL 84-99 allows USACE to supplement state and local entities in flood fighting urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood fight efforts require a Project Cooperation Agreement (PCA) signed by the public sponsor and a requirement for the sponsor to remove all flood fight material after the flood has receded. PL 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for advance measures assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.

- Rehabilitation: Under the authority of PL 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20% cost to the eligible non-federal system owner. All systems considered eligible for PL 84-99 rehabilitation assistance must be in the Rehabilitation and Inspection Program (RIP) prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by USACE on a regular basis. USACE has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

The Stafford Act (PL 93-288). The Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) (The Stafford Act). In accordance with The Stafford Act and the Federal Response Plan, FEMA may direct federal agencies to use available personnel, supplies, facilities, and other resources to provide assistance in the event of a major disaster or emergency declaration. Under the Federal Response Plan, the Department of Defense (DOD) has responsibility for Emergency Support Function (ESF) #3, Public Works and Engineering. DOD has designated USACE as its operating agent for ESF #3, to include planning, preparedness, and response, with assistance to be provided by other branches of DOD as needed. FEMA may direct USACE to use its available personnel, supplies, facilities and other resources to provide assistance in case of a major disaster or emergency declaration by the President. At any time before a Presidential disaster declaration is made, FEMA may direct USACE to perform any emergency work necessary, with or without reimbursement of agency costs. Typical ESF #3 assistance includes the following:

- Needs Assessments: Participation in damage/needs assessments.
- Temporary Power: Provision of emergency power to public facilities.
- Ice and Water: Management and emergency contracting to support public health and safety, such as providing potable water and ice.
- Debris Management: Emergency debris clearance and removal and disposal management of debris from public property.

- Emergency Infrastructure Assessments: Assessments of damaged streets, bridges, ports, waterways, airfields and other facilities necessary for emergency access to disaster victims.

- Critical Public Facility Restorations: Emergency restoration of critical public facilities (including temporary restoration of water supplies and wastewater treatment systems).
- Demolition/Structural Stabilization: Emergency demolition or stabilization of damaged structures and facilities.
- Technical Assistance: Technical assistance including inspection of private residential structures and commercial structures.
- Participate on interagency Hazard Mitigation Teams.

USACE uses pre-awarded contracts that can be quickly activated for missions such as water, ice, temporary roofing, generator installation and debris management.

Department of Defense Directive 3025.1 - Defense Support of Civil Authorities. This directive allows USACE to take immediate action in response to a request for assistance from a civil authority, under imminently serious conditions and if time does not permit approval from higher authority, USACE may provide an immediate response by temporarily employing the resources under their control, subject to any supplemental direction provided by higher headquarters, to save lives, prevent human suffering, or mitigate great property damage within the US. Support provided under immediate response authority should be provided on a cost-reimbursable basis, where appropriate or legally required, but will not be delayed or denied based on the inability or unwillingness of the requester to make a commitment to reimburse the Department of Defense

Rivers and Harbors Act of 1899. (Sections 15, 19, and 20 as amended). USACE has the authority in an emergency to remove sunken vessels or similar obstructions from navigation channels in accordance with current regulations and guidance.

Rehabilitation and Inspection Program. Public Law 84-99 gives USACE the authority for the inspection and rehabilitation of federal and non-federal flood risk management projects. Eligible projects can receive flood-fight assistance during a flood event and rehabilitation/repair assistance after getting damaged from a flood. Rehabilitation of non-federal projects will be cost-shared at 80% federal and 20% from the public sponsor for cost sharable items. Rehabilitation of federal projects will be at 100% federal cost for cost sharable items.

Inspection of Completed Works Program. As an operations and maintenance program within the Rehabilitation and Inspection Program, provides for the periodic inspection of active federal flood risk management projects to determine if the project is being maintained in accordance with USACE criteria. The primary purposes of these

inspections are to prevent loss of life and catastrophic damages; preserve the value of the federal investment; and to encourage non-federal sponsors to bear responsibility for their own protection. This program should assure sponsor compliance with existing agreements that the structures and facilities constructed by the US for flood protection will be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits. In no case does the policy allow for federal expenditures to correct problems caused by lack of adequate local maintenance.

Levee Safety Program / Dam Safety Program. USACE inspects and assesses about 2,500 levee systems nationwide. USACE developed and maintains an online National Levee Database available to the public to help communicate risk. As of 2012, the database included detailed information on more than 14,700 miles of levee systems that are associated with USACE programs, but this is just a fraction of the total number of levees nationwide. More information and more levees are added with contributions of information from other federal agencies, states, and communities.

USACE also publishes and maintains an online National Inventory of Dams available to the public to help communicate risk. USACE itself manages approximately 700 dams it operates and maintains, yet the national inventory contains information on approximately 79,000 dams from all 50 states, Puerto Rico, and 18 federal agencies. The database is published every two years. It consists of dams meeting at least one of the following criteria:

1) High hazard classification - loss of one human life is likely if the dam fails;
2) Significant hazard classification - possible loss of human life and likely significant property or environmental destruction;
3) Equal or exceed 25 feet in height and exceed 15 acre-feet in storage; or
4) Equal or exceed 50 acre-feet storage and exceed 6 feet in height.

Silver Jackets Program. The Silver Jackets Program was established under the USACE National Flood Risk Program to provide a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce the risks associated with flooding and other natural hazards. The Virginia Silver Jackets Team

brings individuals from different agencies together to facilitate collaboration, share information, and leverage resources to identify and implement solutions to reduce flood hazards. In addition to USACE (lead USACE District), the Virginia Team includes staff from the Virginia Department of Emergency Management (lead state agency), Virginia

Department of Conservation and Recreation, Natural Resources Conservation Service, Federal Emergency Management Agency, National Weather Service, and US Geological Survey. The Virginia Silver Jackets Team has been active since June 2010.

Flood Plain Management Services Program. Under Section 206 of the 1960 Flood Control Act (PL 86-645) as amended, upon request, technical assistance and general planning guidance can be provided to state and local governments, Native American Indian tribes, and other non-federal public agencies without charge. Program services also are offered to non-water resources federal agencies and to the private sector on a 100% cost recovery basis. Technical assistance typically includes flood hazard evaluations for site specific locations, developing or interpreting flood flows, flood depths or stages; floodwater velocities; and the extent, duration, and frequency of flooding. General planning guidance can include development of special studies, guides, and pamphlets related to water resources.

Planning Assistance to the States Program. Under Section 22 of the Water Resources Development Act of 1974 (Public Law 93-251), as amended by Section 205 of the 1992 WRDA, USACE can assist states, Native American Indian tribes, local governments, or other non-federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. Studies are cost-shared 50/50 between the federal government and non-federal sponsor (may include 100% work in kind) up to $500,000 annually. Typically, individual studies, of which there may be more than one per State or tribe per year, generally cost $25,000 to $75,000.

Continuing Authorities Program. Congress has provided USACE with a number of standing authorities to study, design, and construct small scale (less than $10 million) water resource projects for various purposes without additional project specific congressional authorization. The sponsoring agency may be a state, county, city, tribe, or other group and must cost share in the project. Projects can include streambank and shoreline protection, flood risk management, navigation improvements, beneficial uses of dredged material, aquatic ecosystem restoration, and USACE project modifications for improvement to the environment. Cost-sharing for study and project costs can vary by business line.

General Investigations Program. Congress can authorize USACE to study, design, and construct major flood risk management, navigation, and ecosystem restoration projects that may cost more than $10 million. A feasibility study is cost-shared 50/50 between the federal government and non-federal sponsor, where the cost-sharing for other project costs can vary by business line.

US Department of Agriculture, Natural Resources Conservation Service (NRCS). The NRCS is dedicated to the conservation of soil and water and related resources. Technical assistance is provided to individuals, groups, organizations and government agencies through conservation districts. Virginia's Departments of Agriculture and Consumer Services and Department of Conservation and Recreation are the state's contacts for NRCS programs:

- Under authority in Public Law 566, numerous flood reduction projects were constructed to address problems in small watersheds. NRCS supports river basin and watershed planning initiatives undertaken by local jurisdictions.
- The Emergency Watershed Protection Program can provide technical and financial assistance to communities to repair and restore clogged and damaged waterways to pre-disaster conditions.
- The Emergency Conservation Program, coordinated with the USDA Farm Services Agency, provides technical assistance to the agricultural community after disasters.
- Wetland Reserve Program provides technical and financial support to help landowners implement wetland restoration, conservation and wildlife practices.

NRCS frequently works with disaster recovery and mitigation in a post-disaster setting in the Commonwealth addressing stream and river flooding issues through the EWP program. This has been used extensively in western mountain flood events since the early 1990s.

US Department of Agriculture, Other Programs. USDA has several loan and grant programs that may support mitigation initiatives and post-disaster recovery.

- Rural Business-Cooperative Development Service Business and Industrial Loans help create jobs and stimulate rural economies by backing rural businesses.
- Rural Housing Service Community Facilities Loans and Grants can be used to construct, enlarge or improve community services for health care, public safety, and public services.
- Water and Waste Grants and Loans are used to develop, replace, or repair water and waste disposal (including storm drainage) systems in rural areas and small towns.
- Farm Service Agency Emergency Conservation Program assistance can be used to rehabilitate certain farmland damaged by floods or other disasters.

- Farm Service Agency Tree Assistance provides cost-shared payments to orchardists, maple sugar producers, greenhouse operators and vineyard growers who incur losses due to damaging weather.
  Federal Multi-Peril Crop Insurance policies insure against losses due to natural causes such as drought, excessive moisture, hail, wind, frost, insects and disease.

  - Non-insured Crop Disaster Assistance Program helps growers of crops for which crop insurance is not available.
- Farm Service Agency Flood Risk Reduction allows farmers to voluntarily execute contracts to receive payments on lands with high flood potential in return for foregoing certain USDA program benefits.
- Supplemental Revenue Assistance Payment Program (SURE) for crop losses in communities declared a disaster by the Secretary of Agriculture.
- Emergency Loans program provides loans to restore or replace essential property damaged in the disaster; finance production losses to crops and livestock; fund essential family living and farm operation expenses, or refinance certain debts.
- Emergency Conserve Program provides funding to address new conservation problems created by disaster that, if not treated, would impair or endanger the land. Funds can be used to rehabilitate farmland damaged by wind erosion, floods, hurricanes, or other natural disasters and to carry out water conservation measures during drought.

US Small Business Administration (SBA). The SBA has the authority to declare disaster areas based on the number of homes and businesses that are affected, even if the event does not warrant a declaration by the President. SBA provides low-interest loans, and can authorize loan amounts up to 20% above the costs of restoration if the applicant agrees to implement mitigation measures. Individuals and businesses can use SBA funds to pay for the non-federal share of HMGP and FMA projects to elevate-in-place, relocate, or flood-proof buildings in flood hazard areas.

SBA Business Physical Damage Loan Program. Available to help businesses and nonprofit organizations repair or replace uninsured damaged property such as real estate, machinery and equipment, inventory, and supplies. SBA requires borrowers to obtain and maintain appropriate insurance, especially if located in a flood hazard area.

SBA Economic Injury Disaster Loan. These loans of 'last resort' provide working capital to small businesses and small agricultural cooperatives to help them through the recovery period.

SBA Disaster Assistance Program Loans. These loans are available to eligible homeowners through the Robert T. Stafford Act as part of the Individual Assistance Program. The loans can include mitigation measures such as drainage improvement, flood proofing and hurricane shutter installation. This program provides an opportunity for citizens within declared jurisdictions to work independently of a traditional grant program to assume responsibility for mitigation of their disaster-prone property.

4.6 State Programs and Capabilities

The following agencies and programs either have a direct or indirect role in mitigation in the Commonwealth. Many of these agencies are a part of the Virginia Emergency Response Team (VERT) as Emergency Support Functions (ESF). These programs play a key role in reducing risk to natural hazards in the Commonwealth and improve the effectiveness of mitigation activities.

Virginia Department of Emergency Management (VDEM).
VDEM's primary mission is to protect the lives and property of Virginia's citizens from emergencies and disasters by coordinating state emergency preparedness, response, recovery and mitigation programs. The responsibility of VDEM is to ensure a comprehensive, efficient and effective response to emergencies and disasters throughout Virginia, including provision of assistance in the absence of events for which federal aid is made available.

VDEM is charged with supporting mitigation planning and administers Hazard Mitigation Assistance (HMA) programs that provide grants to eligible entities to implement cost effective mitigation projects in the pre-disaster and post-disaster periods. VDEM also leads the state and federal Public Assistance Programs, which provide disaster assistance to state agencies, local jurisdictions, and certain private nonprofit entities to repair and restore damaged facilities. Damaged facilities must be repaired in a manner that is compliant with existing codes and standards. VDEM's Emergency Operations Center manages the National Weather Service's Integrated Flood Observing and Warning System (IFLOWS) in several western and southwestern counties. IFLOWS improves local flash flood warnings through a linked wide area monitoring and communications network. With other state agencies and local jurisdictions, VDEM coordinates hurricane evacuations, relying in part on information developed as part of the updated Virginia Hurricane & Tropical Storm Response Plan.

Use of HMA grant programs was explored as funding sources for structural mitigation and data development objectives and strategies. Mitigation most directly interfaces the public assistance program through use of the section 406 PA mitigation program immediately post-disaster. As the structural mitigation measures were not directed specifically at post-disaster actions but were more proactive in examination of holistic, long-term mitigation strategies, public assistance was not directly integrated into the plan.

The Commonwealth of Virginia has many tools in building a mitigation plan to address human caused disasters. Since the 2010 plan, the Commonwealth has developed and/or revised the

Radiological Emergency, Hazardous Materials, Earthquake Response, Terrorism Consequence, Pandemic Influenza, and Technological Hazard plans, which are all part of the COV EOP.

The Commonwealth also has been involved in the Buffer Zone Protection Plan program. VDEM has also taken the lead role in developing the Threat Hazard Identification and Risk Assessment (THIRA) as required by Presidential Preparedness Directive #8 (PPD-8). This update contains a Threat Annex, which profiles manmade and technological threats to the Commonwealth. This Threat Annex is a restricted document, is not a part of the public version of this plan update.

Department of Conservation & Recreation (DCR).

DCR works with Virginians to conserve, protect, and enhance their lands and improve the quality of the Chesapeake Bay and our rivers and streams, promotes the stewardship and enjoyment of natural, cultural and outdoor recreational resources, ensures the safety of Virginia's dams, and serves as the coordinator of all flood protection programs and activities in the Commonwealth. DCR is the State Coordinating Office for NFIP activities, administers the dam safety program, and participates in interagency initiatives concerning coastal erosion. Several DCR programs have the potential to support certain flood mitigation projects. The Virginia Dam Safety, Flood Prevention and Protection Assistance Fund helps local jurisdictions address problem areas by providing state funds to conduct engineering studies for both dams and floodplains.

Some easement and other programs may support floodplain acquisition projects, including Scenic Rivers Program, funding from the Virginia Outdoors Fund, Conservation Reserve & Enhancement Program, and Best Management Practices implemented with Water Quality Improvement grants.

Department of Housing & Community Development (DHCD).

DHCD collaborates with communities to assist them in fully developing their economic potential, and create a healthy, safe and affordable living environment.

Following Hurricane Isabel, DHCD grant staff coordinated with VDEM hazard mitigation and human service managers to target funds to communities hardest hit by Isabel. This effort resulted in more than $5 million in CDGB monies supporting elevations of flood prone properties, increasing the capacity of the Isabel HMGP program ($19 million) by 25%.

After catastrophic disasters of regional proportions, DHCD assists VDEM in coordinating local Long-Term Disaster Recovery Task Forces. These task forces are critical to coordination of various economic assistance and redevelopment programs, volunteer efforts, donations and redevelopment. Strong local recovery task forces have supported disaster recovery in southwest Virginia (flooding and severe weather), Franklin Virginia (Hurricane Floyd), the

City of Poquoson (Hurricane Isabel), Pulaski County & the Town of Pulaski (tornado), the Town of Strasburg (Superstorm Sandy), and Appomattox County & Essex County (tornadoes).

Department of Forestry (DOF).
The DOF is responsible for the protection and development of Virginia's 15.7 million acres of forestland, providing protection and management for forest fire, insects, and disease. DOF is directly responsible for suppression of forest fires, the enforcement of forestry-related laws and supports the state response to natural disasters. The agency maintains an urban forestry strike-team as well as a strong relationship with the logging industry for salvage related harvesting following a natural disaster. Full-time and part-time wildland firefighters are trained and qualified by DOF in fire control tactics and the Incident Command System (ICS). An emergency state and federal interagency response center is located at DOF's headquarters office in

Charlottesville. The agency also maintains mobile command centers that are available for rapid deployment. DOF has initiated statewide wildland fire risk assessments that are maintained in a GIS database.

Virginia Department of Health (VDH)
The mission of the Virginia Department of Health (VDH) is to promote and protect the health of all Virginians. The VDH office of Emergency Preparedness has two federal grants through the US Department of Health and Human Services' (HHS) Office of the Assistant Secretary for Preparedness and Response (ASPR) Hospital Preparedness Program (HPP) and Centers for Disease Control and Prevention (CDC) Public Health Emergency Preparedness (PHEP). HPP and PHEP programs implementation activities in Virginia are focused on development of all healthcare and public health capabilities and ensuring that federal preparedness funds are directed to priority areas as identified through strategic planning efforts.

Preparedness activities funded by the PHEP program are targeted specifically for the development of emergency-ready public health departments that are flexible and adaptable. This funding helps health departments build and strengthen their abilities to effectively respond to a range of public health threats, including infectious diseases, natural disasters, and biological, chemical, nuclear, and radiological events. The Hospital Preparedness Program (HPP) provides leadership and funding through grants and cooperative agreements to improve surge capacity and enhance community and hospital preparedness for health care emergencies.

Virginia Resources Authority (VRA).
The VRA facilitates loans to support local infrastructure for projects concerning environmental quality, public health, transportation and economic development. Since its inception, VRA has funded more than 875 critical projects across the Commonwealth exceeding $5 billion of investment in Virginia's communities. Financing solutions draw on VRA's creativity and unique ability to provide revolving fund loans to localities at below-market interest rates and to issue bonds backed by the moral obligation of the Commonwealth. The VRA staff offers extensive experience and expertise in a variety of financings and provides ongoing assistance to localities for their public projects.

Department of General Services (DGS).
DGS oversees the design and construction of state-owned buildings, applying the state building code provisions related to wind, seismic, snow, and flood loads. The *Governor's Executive Memorandum 2-97* designates DGS as the agency responsible for ensuring state construction proposed in mapped flood hazard areas complies with the NFIP. All proposals are processed as variances, and must be reviewed by DCR.

Virginia Department of Transportation (VDOT).
VDOT is responsible for building, maintaining and operating state's roads, bridges and tunnels, including repairs and replacements required after natural disasters. In accordance with requirements of the Federal Highway Administration, VDOT routinely factors flood hazards into the planning and design of transportation infrastructure, and seismic provisions are required in the southwestern portion of the state.

Risk Management Division, Department of Treasury (RMD).
RMD maintains a blanket insurance policy, which covers all state buildings. Each agency pays premiums based on their buildings and loss history. Claims can be made for building structural and contents damage. RMD also maintains the Virginia Property System (VAPS) database.

Department of Mines, Minerals & Energy (DMME). DMME operates six divisions. Four of these divisions regulate the mining and reclamation of more than 30 different mineral resources such as coal, gas, oil, and non-petroleum minerals like rock and gravel. The primary goal of these divisions is to provide for safe and environmentally sound mineral and fossil fuel

extraction. This includes an objective to eliminate adverse environmental conditions and public safety hazards associated with extraction sites, such as flood hazards and slope failures.

The primary goal of the Division of Geology and Mineral Resources is to enhance the safe and environmentally sound use of Virginia's resources. This includes an objective to reduce the impact of geologic hazards that pose safety and environmental problems, such as landslides and karst. The Division provides office provides maps and digital data to local jurisdictions to be included in local plans. Maps of steep slope areas, including areas where landslides have occurred, are available for some areas.

Department of Environmental Quality (DEQ).
DEQ is the lead agency for the Virginia Drought Monitoring Task Force, DEQ then compiles Drought Status Reports using information from several state and federal agencies. The reports, which are distributed by VDEM, contain sections relating to current climatologically conditions and situation reports regarding water supplies, water quality, forest fire risks and agriculture and crop reports. DEQ also has major responsibility for the environmental consequences of accidents and disasters. The agency plays a major role in hazardous materials containment, testing and abatement and provides oversight to the section 401/404 joint permitting process that oversees any activity with potential impacts to rivers, streams or wetlands.

Virginia Coastal Program
The Virginia Coastal Zone Management (CZM) Program is a network of Virginia state agencies and local governments, established in 1986 through an Executive Order, which administers enforceable laws, regulations and policies that protect coastal resources, strengthen the coastal economy and foster sustainable development. The Department of Environmental Quality (DEQ) serves as the lead agency for Virginia's networked program and administers an annual CZM grant award from the National Oceanic and Atmospheric Administration. The Virginia CZM Program helps agencies and localities develop and implement coordinated coastal policies and solve coastal management problems.

The Program's Coastal Policy Team, composed of representatives of all the program's member agencies, facilitates cooperation among the agencies and provides a forum for discussion and resolution of cross-cutting coastal resource management issues. One of the goals of the program is 'to reduce or prevent losses of coastal habitat, life, and property caused by shoreline erosion, storms, and other coastal hazards in a manner that balances environmental and economic considerations'. The program addresses coastal hazards through

several initiatives that promote the concept of coastal resiliency. Flood hazard-related land features addressed through the program include tidal and non-tidal wetlands, dunes and beaches, riparian buffers, barrier islands, and highly erodible/high hazard lands. Many

Virginia CZM program initiatives have focused on shoreline management and adaptation to sea level rise/ recurrent flooding.

Virginia Silver Jackets

The Virginia Silver Jackets team brings individuals from different agencies together to facilitate collaboration, share information, and leverage resources to identify and implement solutions to reduce flood hazards. In addition to the USACE, the Virginia Team currently includes staff from the Virginia Department of Emergency Management, Virginia Department of Conservation and Recreation, Natural Resources Conservation Service, Federal Emergency Management Agency, National Weather Service, and US Geological Survey. The Virginia Silver Jackets team brings individuals from different agencies and fields of expertise together to facilitate communication, share information, and provide 'one-stop' for local and state governments to obtain information and identify solutions to reduce flood hazards. The Virginia Silver Jackets Team first met on June 23, 2010, and the Charter was signed December 22, 2010; the program has been active since its inception.

4.6.1 Related State Plans and Documents

There are many state plans and documents related to mitigation planning and projects in Virginia. Existing state plans and documents that most affect mitigation are summarized following.

Floodplain Management Plan for the Commonwealth of Virginia (2005) *(Virginia Department of Conservation and Recreation)*. This document contains valuable information on flood hazards and risks, and defines the state's role in floodplain management. It contains a modest action agenda, which is reflective of concerns about reductions in program staff and resources in the early 1990s. A summary of the status of the action agenda set forth in the plan is included.

A review of the plan, on file with VDEM and DCR, recommends that the *Floodplain Management Plan* form the technical basis for the flood-related actions set forth in this plan. However, the 2005 date of the *State Floodplain Management Plan* precluded its use in developing the hazard and risk analysis for this plan, as more recent information and data was available.

Executive Memorandum 2-97, Floodplain Management for State Agencies (1997). Developed in the early 1990s and adopted after Hurricane Fran in 1996, this document is a clear statement of the Governor's intent that all state agencies have some responsibility in managing flood hazards and reducing their impacts through a series of different avoidance, promotion, and coordination activities. A summary review is on file with

VDEM and DCR. As set forth in the Executive Memorandum, the Governor addresses important aspects of state performance:

- DCR is charged as the State Coordinating Office of the NFIP and the technical advisor on the viability of proposed flood mitigation projects;
- All State agencies engaged in construction or land disturbing activities are to comply with locally adopted floodplain management ordinances;

- New state buildings in flood hazard areas must be authorized by a variance obtained from the Director of Department of General Services' Division of Engineering and Buildings in consultation with DCR; and
- The State Corporation Commission determines the adequacy of the Commonwealth's insurance with respect to potential flood damage.

All state agencies follow the directives listed above routinely. Therefore, the Executive Memorandum is considered state policy that must be followed by all state agencies. It represents ongoing mitigation efforts, not new initiatives, so is not further addressed by this plan.

Post Disaster Mitigation Strategy:
Prepared by the Commonwealth and FEMA immediately following establishment of a Disaster Field Office to respond to each presidential declared disaster, the Mitigation Strategy focuses mitigation priorities specific to recovery from that disaster. In conjunction with the state's mitigation goals and vision statement, the Mitigation Strategy priorities are determined to support recovery operations for the specific disaster event. These priorities can include education, support of local officials in administration of floodplain ordinance requirements, targeted technical training and development of specific mitigation messages for affected residents, businesses and local governments.

The Strategy outlines priorities for implementing HMGP funding. Immediate recovery priorities are outlined to guide eligible HMGP applicants.

4.7 Local Capabilities

With respect to addressing natural hazards, local jurisdictions control land use through plans, ordinances and codes. These programs are enabled through state law and regulation and like the many state programs described in this chapter, contribute significantly to mitigation of natural hazards. These programs were not directly considered during development of the *Commonwealth of Virginia Mitigation Plan* because the plan primarily addresses state facilities determined to be

at risk following analysis of vulnerability of state facilities to natural hazards. However, these efforts are relevant as state agencies generally manage state facilities in a manner that is consistent and complementary of local comprehensive planning and zoning. State–sponsored construction adheres to the Uniform Statewide Building Code that incorporates the International Building Code.

Use of the Uniform Statewide Building Code is required for all new construction as well as substantial improvements within Commonwealth cities, counties, and towns. Many of the local strategies that were identified by Virginia jurisdictions reflect the building code and address natural hazards. These local initiatives significantly contribute to mitigating hazards.

Comprehensive Plans are prepared by local planning commissions and address the physical development of land within a jurisdiction's boundaries. The comprehensive plan "shall be made with the purpose of guiding and accomplishing a coordinated, adjusted and harmonious development of the territory which will, in accordance with present and probable future needs and resources, best promote the health, safety, morals, order, convenience, prosperity and general welfare of the inhabitants" (§15.2-2223, *Code of Virginia*). Most plans evaluate and provide guidance for both land uses and the environment. Residential, business, industrial, agricultural, parks and open space, public land, floodplains, transportation corridors, community facilities, historical districts and areas targeted for redevelopment are all addressed within the plan. Also included are demographic trends such as population densities and information on age and quality of housing stock.

Zoning Ordinances are for general purpose of promoting health, safety or general welfare of the public. Some consideration to the following is given within each zoning district, where applicable:

- adequate light, air, convenience of access, and safety from fire, flood, crime and other dangers;
- provision of adequate police and fire protection, disaster evacuation, water, sewerage, flood protection, and other public requirements; and
- protection against loss of life, health, or property from fire, flood, panic and other dangers.

Land Subdivision and Development Ordinances are prescribed by statute and provide restrictions for plats, utilities, and streets, and address flood control, drainage, and other regulations that control the density and use of the land. (§15.2-2241, *Code of Virginia*).

2012 Uniform Statewide Building Code includes provisions related to wind hazards, snow loads, seismic risk flood hazards, and structural fire hazards. The Uniform Statewide Building Code, based on the model codes established by the International Code Council, is promulgated by the Board of Housing and Community Development (BHCD) which supersedes previous

building codes and regulations (§36-98, *Code of Virginia).* The code has been cross-walked with NFIP regulations and is consistent with local floodplain ordinances. The State Building Code Office provides technical assistance and interpretation of regulations to local governments. Periodic updates to the statewide building code usually include adoption of the current IBC, IRC, and the IEBC along with other state-specific regulations. The most recent adoption provided wind strengthening measures that will reduce damages from severe storms and hurricanes.

Floodplain Management. Flooding has always been problematic in the Commonwealth with many severe floods documented soon after European settlement. To complement the NFIP, Virginia's General Assembly enacted the Virginia Flood Damage Reduction Act of 1989. This legislation was the result of several disastrous floods or coastal storms that hit the state between 1969 and 1985. To improve Virginia's flood protection programs and place related programs in one agency, responsibility for coordination of all state floodplain programs was transferred in 1987 from the Water Control Board to the Department of Conservation and Recreation (DCR). DCR was named manager of the state's floodplain program and designated coordinating agency of the National Flood Insurance Program under the act, §10.1-602, and a governor's memorandum released in July 1997. Floodplain Management Program staff work with localities to establish and enforce floodplain management regulations. Localities use the program's state model ordinances, in which minimum standards for local regulations are set, to write their own to participate in the NFIP. Local governments can set more restrictive standards to ensure higher levels of protection for residents in flood hazard areas. Also, the state has used the Virginia Uniform Statewide Building Code to set construction standards for structures built in FEMA-identified flood hazard areas.

Floodplain zoning regulates development within floodplains. The program's main goal is to protect people and their property from unwise floodplain development practices. It also protects society from costs associated with the development of risk-prone floodplains.

Stormwater Management, *(Title 10.1, Chapter 6, Article 1.1 of the Code of Virginia)* These statutes specifically set forth regulations regarding land development activities to prevent water pollution, stream channel erosion, depletion of groundwater resources, and more frequent localized flooding to protect property value and natural resources. Stormwater management

programs are intended to address these adverse impacts and comprehensively manage the quality and quantity of stormwater runoff on a watershed-wide basis.

CBLA and the Virginia Bay Act, *(Title 10.1, Chapter 21 of the Code of Virginia)* The Bay Act is designed to improve water quality in the Chesapeake Bay and its tributaries by requiring the use of effective conservation planning and pollution prevention practices when using and developing environmentally sensitive lands. At the heart of the Bay Act is the concept that land can be used and developed in ways that minimize negative impacts on water quality. The first sentence of the Bay Act serves as a theme for the entire statute:

"Healthy state and local economies and a healthy Chesapeake Bay are integrally related; balanced economic development and water quality protection are not mutually exclusive."

Local Bay Act programs started implementing the provisions of the Bay Act regulations in the early '90s by amending their local comprehensive plans and land use ordinances. These localities have incorporated water quality protection measures consistent with the Bay Act Regulations into their zoning ordinances, subdivision ordinances, and comprehensive plans. The regulations address non-point source pollution by identifying and protecting certain lands called Chesapeake Bay Preservation Areas. The regulations use a resource-based approach that recognizes differences between various land forms and treats them differently.

4.7.1 Effectiveness of Local Policies, Programs, and Capabilities

As most mitigation activities in the Commonwealth are carried out at the local level, it is important to determine the effectiveness of local policies, programs, and capabilities. Comprehensive planning throughout the state has required localities to look at future land use planning. This is very effective in conjunction with local floodplain ordinances in restricting the type of development within the floodplain.

Hazard mitigation plans at least partially integrated into comprehensive plans; approximately half of the comprehensive plans consider the hazard mitigation plan. This integration assists local decision makers in determining the risks of future development in hazard areas

4.7.2 Local Plan Capability Assessments

Capability assessments from each of the local hazard mitigation plans were reviewed to determine the capabilities at the regional and local level. Table 4.4 is a display of the common plans, codes, and ordinances that were found in the local plans. This table may not be a true representation of each locality, but rather indicates that at least one locality within the plan had these capabilities in place. Comprehensive Land Use plans, subdivision ordinances, and

building codes are represented throughout local capabilities as required through the codes referenced earlier.

Table 4.4 - Local Capability Matrix

Local Hazard Mitigation Planning Area/Entity	Comprehensive Plan	Land Use Plan or Ordinance	Subdivision Ordinance	Zoning Ordinance	NFIP/Floodplain Ordinance	Building Code & Official	Local EOP	Stormwater Management	Fire Codes	Capital Improvement	Hazard Mitigation Plan	Economic Development
Accomack-Northampton PDC (date unknown)	X	X	X	X	X	X	--	--	--	--	X	--
Commonwealth Regional Council (2016)	X	X	X	X	X	X	X	X	X	X	X	X
Central Shenandoah PDC (2013)	X	X	X	X	X	X	X	--	--	--	X	--
Cumberland Plateau PDC (2013)	X	X	X	--	X	X	X	--	--	--	X	X
George Washington Regional Commission (2017)	X	X	X	X	X	X	X	X	X	X	X	X
Hampton Roads (2016)	X	X	X	X	X	X	X	X	X	X	X	X
LENOWISCO PDC (2013)	X	X	X	X	X	X	X	X	--	--	X	--
Middle Peninsula PDC (2016)	X	X	X	X	X	X	--	X	--	X	X	X
Mount Rogers PDC (2011)	--	X	--	--	X	X	--	--	--	--	X	--
New River Valley PDC (2011)	X	X	X	X	X	X	X	X	--		X	X
Northern Neck PDC (2011)	X	X	X	X	X	X	X	--	--	--	X	--
Northern Shenandoah Valley Regional Commission (2012)	X	X	X	X	X	X	X	X	--	X	X	--
Northern Virginia (2016)	X	X	X	X	X	X	X	X	X	X	X	X
Rappahannock-Rapidan Regional Commission (2012)	X	X	X	X	X	X	X	X	X	X	X	--
Region 2000 Partnership (2013)	X	X	X	X	X	X	X	X	--	X	X	--
Richmond-Crater (2017)	X	X	X	X	X	X	X	X	X	X	X	X
Roanoke Valley-Alleghany Regional Commission (2013)	X	X	X	X	X	X	X	X	--	X	X	--
Southside PDC (2013)	X	X	X	X	X	X	X	X	X	X	X	X
Thomas Jefferson PDC (2012)	X	X	X	X	X	X	X	--	X	--	X	--
West Piedmont PDC (2011)	X	X	X	X	X	X	X	X	X	X	X	X

General Obstacles and Challenges

Coordination of Post-Disaster Assistance

There are numerous opportunities to tap into federal and state funds to reduce future risk to the Commonwealth. The challenge is coordination of these efforts. The Commonwealth is currently undertaking a statewide recovery plan that will help taking agencies with recovery/mitigation responsibilities.

Cost Effectiveness

With an emphasis on community flood mitigation projects, determining cost effectiveness isn't always as cut and dry as the residential projects. More training and tools to specifically address these type of projects would be useful.

Non-federal Match

There are open HMA projects for which properties end up dropping out do to the inability to come up with the non-federal and non-state share of the project. There has been a shift in dynamic to try and identify more of a private investment moving forward, which will hopefully help address this issue.

Endnotes

[1] FEMA. *National Flood Insurance Program and the Consolidated Appropriations Act of 2014 – Fact Sheet.* February 10, 2014. Retrieved 06.07.17 from https://www.fema.gov/media-library/assets/documents/90829
[2] FEMA. *Homeowner Flood Insurance Affordability Act Overview.* April 03, 2014. Retrieved 06.07.17 from https://www.fema.gov/media-library/assets/documents/93074
[3] FEMA. Disaster Declarations. Retrieved 06.07.17 from https://www.fema.gov/disasters?field_state_tid_selective=22&field_disaster_type_term_tid=All&field_disaster_declaration_type_value=DR&items_per_page=20
[4] FEMA. Disaster Declarations. Retrieved 06.07.17 from https://www.fema.gov/disasters?field_state_tid_selective=22&field_disaster_type_term_tid=All&field_disaster_declaration_type_value=DR&items_per_page=20

Disaster Mitigation Act of 2000

§201.4(c)(ii): The State mitigation strategy shall include a] description of State goals to guide the selection of activities to mitigate and reduce potential losses.
§201.4(c)(3)(iii): An identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified.
§201.4(c)(3)(iii): The State mitigation strategy shall include an] identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.
§201.4 (d): Review and updates. Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities and resubmitted for approval to the appropriate Regional Director every three years. The Regional review will be completed within 45 days after receipt from the State, whenever possible. We also encourage a State to review its plan in the post-disaster time frame to reflect changing priorities, but it is required.

5.1 2018 Plan Update

The primary focus is to tie the Mitigation Strategy directly to the results of the HIRA (Chapter 3). The Mitigation Strategy is a critical part of the process, as it identifies and prioritizes proposed actions to reduce future risk to natural hazards. Section 3.10 of the HIRA identifies flooding as the most frequent and costly hazard in terms if loss of life and property in Virginia. There is no coincidence that the Mitigation Strategy is targeted at reducing impacts of flooding.

The Commonwealth of Virginia Hazard Mitigation Plan is structured with a traditional hierarchy that begins with a mitigation vision supported by four major goals. The four major goals are supported by objectives, and the objectives are supported by mitigation actions, each of which contribute to reducing risk in the Commonwealth and support the Mitigation Vision.

VISION:

It is the Commonwealth's vision to promote resiliency and reduce the long-term impacts of hazards on human, economic, and natural resources throughout the state.

5.2 Virginia Mitigation Goals

During the plan update process, the previously identified mitigation goals were reviewed by both the Advisory Committee and the Working Group members. The goals were either validated or modified through discussion and consensus among the members. These goals provide the overarching direction of the plan's mitigation activities. The four goals are as follows:

Goal #1 (modified)
Identify and implement projects that will reduce or eliminate long-term risk, directly reduce impacts from hazards, and maintain continuity of critical societal functions. This includes reducing risk to repetitive loss and severe repetitive loss properties.

Goal #2 (validated)
Incorporate mitigation concepts and objectives into existing and future policies, plans, regulations, and laws in the Commonwealth.

Goal #3 (modified)
Improve the quality and accessibility of the data used in the hazard identification and risk assessment and analysis process in state, multi-jurisdictional, and higher education hazard mitigation plans.

Goal #4 (modified)
Promote and support a whole community approach to awareness of hazards, their risk, and potential mitigation actions in order to increase resiliency.

5.3 Virginia Mitigation Categories

The four goals are supported by mitigation objectives: prevention of future risk, protection of the built environment, natural resource protection, hazard modification through construction, emergency services, public education and awareness, and risk analysis.

1. **Prevention of Future Risk**
Preventative activities are intended to keep hazard problems from getting worse, and are typically administered through government programs or regulatory actions that influence the way land is developed and buildings are built. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has

not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning
- Building codes
- Open space preservation
- Floodplain regulations
- Stormwater management regulations
- Drainage system maintenance
- Capital improvement programming
- Setbacks for hazard areas
- Use of pervious surfaces

2. Protection of the Built Environment

Property protection measures involve the modification of existing buildings and infrastructure to help them better withstands the forces of hazard, or removal of the structures from hazardous locations:

- Acquisition and demolition
- Acquisition and relocation
- Structural elevation
- Critical facilities and infrastructure protection
- Retrofitting (i.e., windproofing, floodproofing, seismic design techniques, ignition resistant construction materials, etc.)
- Safe rooms, shutters, shatter-resistant glass
- Insurance
- Impervious surface modifications
- Wildfire hazard mitigation

3. Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation or conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection
- Watershed management
- Riparian buffers
- Forest and vegetation management (e.g., fire resistant landscaping, fuel breaks, defensible space, etc.)

- Erosion and sediment control
- Wetland preservation and restoration
- Habitat preservation
- Slope stabilization

4. Hazard Modification Through Construction

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event through construction. They are designed by engineers and usually managed or maintained by public works staff:

- Reservoirs
- Dams/levees/dikes/floodwalls
- Diversions/detention/retention
- Channel modifications
- Storm Sewers
- Drainage improvements
- Minor localized flood reduction projects

5. Emergency Services

Although not typically considered a mitigation technique, emergency service measures do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems
- Evacuation planning and management
- Emergency response training and exercises
- Continuity of operations planning
- Sandbagging for flood protection
- Elevating contents for flood protection
- Installing temporary shutters for wind protection
- Generator and quick connects
- Community Wildfire Protection Plan (CWPP) implementation
- Dry hydrant installation

6. Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Outreach projects
- Speaker series/demonstration events
- Hazard map information
- Real estate disclosures
- Library materials
- School children educational programs
- Hazardous expositions

7. Risk Analysis

Whether it is writing a plan or implementing a bricks and mortar project, analyzing risk is the backbone for developing a project scope of work or mitigation actions. Examples of measures to analyze risk include:

- Hazard identification and risk assessment
- Threat Hazard Identification and Risk Assessment (THIRA)
- Benefit-cost analysis (BCA)
- Probability
- Hazard history
- Dollar losses and impacts

After the goals and objectives were validated, the next step was to tie them to the results of the HIRA. Table 5.1 shows the relationship between the hazards themselves, and the categories of mitigation.

Table 5.1 – Mitigation Options Matrix

Mitigation Technique		Prevention of Future Risk	Protection of Built Environment	Natural Resource Protection	Hazard Modification Through Construction	Emergency Services	Public Education and Awareness
HIGH RISK HAZARDS	Flood	✓	✓	✓	✓	✓	✓
	Non-Rotational Wind	✓	✓	✓		✓	✓

	Severe Winter Weather	✓	✓			✓	✓
MEDIUM RISK HAZARDS	Wildfire	✓	✓	✓		✓	✓
	Drought	✓		✓		✓	✓
	Tornado	✓	✓			✓	✓
LOW RISK HAZADRS	Flooding Due to Dam Failure	✓	✓	✓	✓	✓	✓
	Earthquake	✓				✓	✓
	Landslide	✓		✓	✓	✓	✓
	Karst	✓					✓
	Land Subsidence	✓					✓
	Solar Storm	✓					✓
	Communicable Disease	✓		✓		✓	✓

5.4 Strategy & Project Prioritization

The Advisory Committee and Working Group both chose to keep the prioritization criteria from the 2010 plan: human health and safety, continuity of operations, cost and feasibility, loss reduction and economic recovery, benefits multiple agencies and organizations, multi-hazard mitigation, and focused mitigation efforts.

Table 5.2 Prioritization Criteria

Criteria	Description
Human Health and Safety	Action protects human health, enhances public safety, protects vulnerable populations, or mitigates significant damage potential.
Continuity of Operations	Action protects the Commonwealth's ability to maintain continuity of operations, communications, critical infrastructure, and emergency management functions during a disaster
Cost and Feasibility	Action is technically feasible and environmentally sound in terms of cost effectiveness, ability to be completed in a timely fashion, availability of expertise and technical support and ease of implementation

Loss Reduction and Economic Recovery	Action will reduce long term financial losses and promote rapid economic recovery
Benefits multiple agencies and organizations	Action benefits several groups, communities, or state agencies covering a large geographic area
Multi-Hazard Mitigation	Action mitigates damage to critical resources from more than one hazard
Focused Educational Efforts	Strategies for educational efforts will be carried out in a timely and relevant manner, messages are consistent, simple, and straightforward and in the appropriate media format, including alternative formats for people with different needs, and are directed toward people and property that are located within high hazard areas.

The ranking process for the 2013 update followed a similar process to the previous plan. Strategies were presented and broken out by hazard. Committee members had the opportunity to review the actions and prioritize each action, as applicable. The committee members were instructed to vote on the following score system:

- 0: Strategy met none of the criteria
- 1: Strategy met some of the criteria
- 2: Strategy met most of the criteria

The scores were then tallied and the range of scores is as follows:

- Low: 0 – 4
- Medium: 5 – 7
- High: 8 – 10

For the 2018 update, each Advisory Committee and Working Group member had the opportunity to review the actions and validate, affirm, or change the prioritization of each action, as applicable. There were no changes to the action priorities. If the action was new, the Advisory Committee and Working Group members prioritized actions based on the prioritization criteria established in Table 5.2; however, the prioritization was completed more as a verbal exercise within the planning group.

5.5 Mitigation Actions

This section identifies the status of mitigation actions identified in previous versions of this plan, as well as new strategies that were submitted under this revision. The action description includes

the goal, category, status, priority ranking, cost estimate, expected timeline, hazard to be mitigated, and lead agency.

Each of the following mitigation actions contribute towards satisfying the mitigation goals, and therefore contribute to the overall Mitigation Vision. The mitigation actions are grouped by hazard with the following prefixes: Flood (FL), Multi-hazard (MH), Wildfire (WF), Geologic (G), Dam Failure (DF), Human-Caused (HC), Communicable Disease (CD), and Solar (S).

Real-Time Flood Warning System

Mitigation Action FL-1

Through collaborative efforts, identify opportunities to improve flood warning capabilities in areas of higher risk. As technology evolves, so should capabilities and methods to provide warning of imminent flood impacts.

BACKGROUND INFORMATION

Cost Benefit:	The warning capabilities and potential to capture additional historical data on storm events is a direct benefit.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1,4
Category(s) Addressed:	5,6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	NWS, VDEM, DCR, USGS, FEMA, local jurisdictions
Implementation Schedule:	As funding becomes available
Status:	**ONGOING**

ADDITIONAL COMMENTS

USACE has the following programs that could apply to a real-time flood warning system: Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Acquire and Install Additional Stream Gauges

Mitigation Action FL-2
Pursue funding to purchase and install additional stream gauges in areas of the state that currently do not have automated flood monitoring capabilities.

BACKGROUND INFORMATION

Cost Benefit:	The warning capabilities and potential to capture additional historical data on storm events is a direct benefit.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1,4
Category(s) Addressed:	5,6
Priority (High, Medium, Low):	High
Estimated Cost:	Project and Specification Dependent
Potential Funding Sources:	HMGP 5% funds, Federal Funds
Lead Agency/Responsible Department:	VDEM, DCR, Local Governments, USGS, Silver Jackets
Implementation Schedule:	As Funding Becomes Available
Status:	**Ongoing**

ADDITIONAL COMMENTS

Through Cooperative Gaging Programs, USACE works with the USGS and NWS to help fund installation and maintenance of short/long term gages that are associated with a USACE study, project, or activity. In addition, USACE has the following programs that could apply to acquiring and installing additional stream gauges: Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Reduce the Impact of Flooding on the Virginia Tech Campus

Mitigation Action FL-3

Reduce the Impact of Flooding on the Virginia Tech Campus

Mitigation Action FL-3

Coordinate with adjacent locality to evaluate and improve upstream storm water management practices. Evaluate and expand size of underground stream diversion piping system to improve storm water capacity and reduce surface flows. Project would reduce flooding risks for repetitive loss buildings located on a 100-year floodplain and additional structures located on a 500-year floodplain. This project supports the university's sheltering initiative.

BACKGROUND INFORMATION

Cost Benefit:	The warning capabilities and potential to capture additional historical data on storm events is a direct benefit.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3,5,6
Priority (High, Medium, Low):	High
Estimated Cost:	Undetermined
Potential Funding Sources:	HMGP, FEMA Public Assistance
Lead Agency/Responsible Department:	DCR, Virginia Tech
Implementation Schedule:	As funding becomes available
Status:	**NOT STARTED**

ADDITIONAL COMMENTS

VDEM and VT are discussing potential for HMGP application.

While USACE cannot solve local storm water drainage issues, as a State institution, USACE could possibly provide water resources related study assistance through the Planning Assistance to States or Flood Plain Management Services Programs. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

TIDEWATCH Program

Mitigation Action FL-4

TIDEWATCH presently collects water level observations at Jamestown (James River N. Ferry Pier) and Hampton/Poquoson (Back River) using VIMS-owned microwave radar sensors with GOES radio transmission to a server at VIMS at half-hour intervals. Six-minute water levels referenced to NOAA tidal datums (HAT, MHHW, MSL, MLLW, LAT) are displayed along with data from six active NOAA stations in lower Chesapeake Bay at www.vims.edu/tidewatch. Processed data stored in VIMS data base archives are also referenced to NGVD29 and NAVD88. A 24-hour operational forecast component for TIDEWATCH is presently under development with funding provided by NOAA/NWS. Funds are needed to maintain operation and add one new station to TIDEWATCH.

BACKGROUND INFORMATION

Cost Benefit:	The warning capabilities and potential to capture additional historical data on storm events is a direct benefit.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1,3,4
Category(s) Addressed:	5,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Undetermined
Potential Funding Sources:	Agency Funds, HMGP 5%
Lead Agency/Responsible Department:	DCR, VIMS
Implementation Schedule:	As funding becomes available
Status:	**ONGOING**

ADDITIONAL COMMENTS

Funding is needed to install additional tide gauges.

The USACE Silver Jackets Program may be able to provide assistance.

Acquisition and Demolition of Flood Prone Properties

Mitigation Action FL-5

Assist localities, state agencies, PDCs, and eligible PNPs to identify vulnerable structures and apply for funding to implement acquisition and demolition projects. Acquisition and demolition projects completely remove the structure from the floodplain, reducing any future damages. The property is then deed restricted to be open space in perpetuity. This insures that no structure can be built on the parcel of land that could sustain future damages and possible insurance claims against the NFIP. Repetitive Loss and Severe Repetitive Loss properties are targeted for this project type.

BACKGROUND INFORMATION

Cost Benefit:	The acquisition and demolition of flood prone properties are typically cost effective, depending on the first-floor elevation, history of flooding and fair market value of the structure.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3
Priority (High, Medium, Low):	High
Estimated Cost:	Dependent on Value of Property
Potential Funding Sources:	HMA Programs
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

VDEM and local communities across the Commonwealth have successfully acquired and demolished over 400 flood prone properties. This project type is completely voluntary, and requires written voluntary participation agreements from property owners. Individual property owners cannot apply directly to FEMA, they are required to work through their community or other eligible entity as a sponsor. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Acquisition and Demolition of Flood Prone Properties

Mitigation Action FL-5

USACE has the following programs that could apply to acquisition and demolition of flood prone properties: Continuing Authorities, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Acquisition and Relocation of Flood Prone Properties

Mitigation Action FL-6

Assist localities, state agencies, PDCs, and eligible PNPs to identify vulnerable structures and apply for funding to implement acquisition and relocation projects. Acquisition and relocation projects completely remove the structure from the floodplain, reducing future damages. The parcel of land is acquired, and the structure is physically moved to another parcel located outside of the floodplain. The remaining parcel of land in the floodplain is deed restricted to be open space in perpetuity. This insures that no structure can be built on the parcel of land that could sustain future damages and possible insurance claims against the NFIP. Repetitive Loss and Severe Repetitive Loss properties are targeted and prioritized for this project type.

BACKGROUND INFORMATION

Cost Benefit:	Cost effectiveness is project dependent; however multiple properties can be included together for an aggregate benefit cost ratio.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3
Priority (High, Medium, Low):	High
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMA Funds, USACE
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Acquisition and relocation projects were very successful in reducing risk in the Central Shenandoah Valley, particularly Glasgow after Hurricane Fran in 1996. This project type is voluntary, and requires written voluntary participation agreements from property owners. Individual property owners cannot apply directly to FEMA, they are required to work through their community or other eligible entity as a sponsor. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Acquisition and Relocation of Flood Prone Properties

Mitigation Action FL-6

USACE has the following programs that could apply to acquisition and relocation of flood prone properties: Continuing Authorities, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Floodproofing of Public, Commercial, and Historic Buildings

Mitigation Action FL-7

Assist localities, state agencies, PDCs, and eligible PNPs to identify vulnerable structures and apply for funding to implement floodproofing projects. Floodproofing is a more viable option for businesses, public buildings, and historical buildings. Floodproofing typically involves keeping the water from entering the structure, either by direct access or through seepage. This is usually accomplished by installing permanent and/or removable barriers at openings such as doors or full pane windows. It may be necessary to also apply a sealant around the structure to prevent water from seeping in. Repetitive Loss and Severe Repetitive Loss properties are targeted and prioritized for this project type.

BACKGROUND INFORMATION

Cost Benefit:	Floodproofing may be less costly than acquisition or elevation, and if feasible provides protection to up to a 100-year event in most cases.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3
Priority (High, Medium, Low):	High
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMA Funds, USACE
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Floodproofing projects have been implemented for businesses in the cities of Salem and Staunton. Another project is currently being considered in Norfolk, VA. This project type is completely voluntary, and requires written voluntary participation agreements from property owners. Individual property owners cannot apply directly to FEMA, they are required to work through their community or other eligible entity as a sponsor.

In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Floodproofing of Public, Commercial, and Historic Buildings

Mitigation Action FL-7

USACE has the following programs that could apply to flood proofing of public, commercial, and historical buildings: Continuing Authorities, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Mitigation Reconstruction of Severe Repetitive Loss Properties

Mitigation Action FL-8

Assist localities and PDCs to identify Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties and apply for funding to implement mitigation reconstruction projects. Mitigation reconstruction result in the demolition of the existing structure, and the construction of a code-compliant and hazard resistant structure on an elevated foundation system. Eligible costs are limited to $150,000 federal share per property.

BACKGROUND INFORMATION

Cost Benefit:	Cost effectiveness is project dependent; however multiple properties can be included together for an aggregate benefit cost ratio.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3
Priority (High, Medium, Low):	Medium
Estimated Cost:	Project Dependent
Potential Funding Sources:	SRL Funds
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

VDEM assisted the Town of Chincoteague and Northumberland County in applying for the first mitigation reconstruction projects in the state through the SRL program. The property in Chincoteague has been completed. This project type is completely voluntary, and requires written voluntary participation agreements from property owners. Individual property owners cannot apply directly to FEMA, they are required to work through their community or other eligible entity as a sponsor. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Minor Localized Flood Reduction Projects

Mitigation Action FL-9

Assist localities and PDCS to identify vulnerable structures and infrastructure and apply for funding to implement minor localized flood reduction projects. These projects are designed to lessen the frequency or severity of flooding and decrease predicted flood damages, such as the installation or modification of culverts and stormwater management activities such as creating retention and detention basins.

BACKGROUND INFORMATION

Cost Benefit:	Cost benefit is project dependent. If proposed solution protects structures, roads, and utilities it is more likely to be cost effective.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3,4
Priority (High, Medium, Low):	High
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMA Funds
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

VDEM has assisted Hanover County, Henry County, and the Town of Abingdon apply for and implement drainage improvement projects to reduce flooding.

While USACE cannot solve local storm water drainage issues, USACE could possibly provide water resources related study assistance through the Planning Assistance to States or Flood Plain Management Services Programs. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Elevation of Flood Prone Properties

Mitigation Action FL-10

Assist localities, state agencies, PDCs, and eligible PNPs to identifying vulnerable properties and apply for funding to implement elevation projects. Elevations involve the physical raising of a structure to base flood elevation (BFE) or higher if required in local floodplain ordinances. Structure elevation may be achieved through a variety of methods, including elevating on continuous foundation walls; elevating on open foundations, such as piles, piers, posts, or columns; and elevating on fill. Foundations will require designs to properly address all loads and be appropriately connected to the floor structure above, and utilities are required to be properly elevated as well. Repetitive Loss and Severe Repetitive Loss properties are targeted and prioritized for this project type.

BACKGROUND INFORMATION

Cost Benefit:	Cost effectiveness is project dependent; however multiple properties can be included together for an aggregate benefit cost ratio.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3
Priority (High, Medium, Low):	High
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMA Funds, USACE
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

VDEM and local communities across the Commonwealth have successfully elevated over 270 flood prone properties. This project type is completely voluntary, and requires written voluntary participation agreements from property owners. Individual property owners cannot apply directly to FEMA, they are required to work through their community or other eligible entity as a sponsor. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Elevation of Flood Prone Properties

Mitigation Action FL-10

USACE has the following programs that could apply to elevation of flood prone properties: Continuing Authorities, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Integrate Mitigation Of Repetitive Loss Structures into Local Hazard Mitigation Plans

Mitigation Action FL-11

Integrate Repetitive Loss and Severe Repetitive Loss list structural targeting into local, regional and state mitigation planning and grant implementation property targeting.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	2
Category(s) Addressed:	1,5,6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	HMA Funds
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Each local hazard mitigation plan is required by VDEM to identify the types and numbers of Repetitive Loss properties for each jurisdiction.

Identification of Repetitive Loss Properties with Non-Specific Addresses

Mitigation Action FL-12

During the process of identifying Repetitive Loss properties that were mitigated using HMA funds it was discovered that over 550 of the more than 6,000 addresses provided by the NFIP Repetitive Loss list were vague and descriptive rather than specific. This vagueness creates flawed data for comparison of HMA funded structural mitigation activities.

BACKGROUND INFORMATION

Cost Benefit:	Will provide better targeting for reducing repetitive loss.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	2,3,4
Category(s) Addressed:	1,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not determined
Potential Funding Sources:	Hazard Mitigation Assistance Funds, FEMA Technical Assistance
Lead Agency/Responsible Department:	VDEM, DCR, FEMA, Local Governments
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

An initial report of mitigation repetitive loss properties was submitted to FEMA in June of 2011, which included mitigation properties and AW501 forms for 52 properties. As more projects are completed and closed, additional AW501 forms will be provide to FEMA to remove the property from the list. Since this process is already established, quarterly reports to FEMA should not be needed as the properties will be removed from the list as they are mitigated. Through FEMA technical assistance, VDEM and FEMA have identified the locations of over 200 inaccurate addresses because of a technical assistance request after Hurricane Irene (DR 4024). In addition, VDEM has required local hazard mitigation plans to include a repetitive loss strategy to identify addresses that are inaccurate in the Repetitive Loss list. The Repetitive Loss strategy requirement in local hazard mitigation plans also addresses verification of location of properties.

Identification of Repetitive Loss Properties that Have been Mitigated by Means other than HMA Funds

Mitigation Action FL-13

During the discussion of identifying repetitive loss properties that were mitigated using HMA funds VDEM was questioned by FEMA Region III as to what properties on the Repetitive Loss list had been mitigated by other than HMA funding. It was suggested that the Commonwealth cross-reference the properties that had received Increased Cost of Compliance (ICC) funding to provide this information to the NFIP. The issue associated with this is three-fold: first, the descriptive address issue as discussed in **FL-12** directly affects the complete documentation of mitigated properties; second, the Commonwealth is not willing to either make the assumption that all ICC funds were appropriately used in accordance to all federal guidelines when the Commonwealth is not associated with the mitigation activity; third, it presumes that the localities have readily accessible and accurate documentation associated with all aspects of the usage of the ICC funds by the property owner. Further, there is no local-to-state reporting mechanism currently in place to identify these properties. .

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	2,3,4
Category(s) Addressed:	1,6,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM, DCR, FEMA, Local Governments
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Each local hazard mitigation plan that comes through VDEM for approval must have a mitigation strategy to address repetitive loss properties, including properties that have been mitigation by means other than HMA funds. This strategy will ensure that future repetitive loss lists will be reviewed by the local communities to determine if mitigated and if so by what means. Due to multiple disaster declarations over the past years, an annual and quarterly report on non-HMA mitigation properties has not been developed.

Real Time Flood Inundation Program

Mitigation Action FL-14

Determine usefulness of existing data being calculated through stream, rain, and water quality gages and develop a method to improve and coordinate data sources into a real-time flood mapping system.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	3
Category(s) Addressed:	5,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Federal Funds
Lead Agency/Responsible Department:	DCR, FEMA, USGS, VDEM, NWS, USACE, Silver Jackets
Implementation Schedule:	As Funding Becomes Available
Status:	**Not Started**

ADDITIONAL COMMENTS

USACE has the Silver Jackets Program that could help coordinate/fund, by working with other Federal agencies, real-time flood inundation mapping. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Incorporate Updated Flood Frequency Data into Updated DFIRMs

Mitigation Action FL-15

Work with FEMA and USGS to establish a process for incorporating updated flood frequency data into updated DFIRMs as a part of the Risk Map efforts. USGS flood frequency data is typically updated on a 15-year basis.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	3
Category(s) Addressed:	1,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Federal Funds
Lead Agency/Responsible Department:	FEMA, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Flood frequency data was not included in most DFIRMs across the state, but is being included in FEMA's RiskMap products that will become available in draft form beginning Spring 2013.

Hazard Evaluation of Critical and State-Owned Facilities in Coastal Areas

Mitigation Action FL-16

Flooding is Virginia's most significant hazard. Coastal Virginia is experiencing increased risk due to sea-level rise (up to 2.3 feet over the past 100 years). State-owned and critical facilities adjacent to shorelines or in low-lying areas may be at greater risk today than they were at the time of construction. A detailed evaluation of ground stability and susceptibility to modern storm tides (storm surge plus highest astronomical tides) will identify facilities in need of mitigation or relocation. Project to be conducted in partnership with Virginia Institute of Marine Science, Shoreline Studies Program.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	3,4
Category(s) Addressed:	1,6,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	$360,000
Potential Funding Sources:	Not Determined, possibly 5% HMGP
Lead Agency/Responsible Department:	DCR, DMME
Implementation Schedule:	Short Term
Status:	**Not Started**

ADDITIONAL COMMENTS

DMME continues to seek funding to support this project.

USACE has the following programs that could apply to hazard evaluation of critical and State-owned facilities in coastal areas: Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Encourage NFIP Participation

Mitigation Action FL-17

Develop and implement an education program for PDCs, localities, private non-profits, and citizens regarding the NFIP program and flood insurance generally.

BACKGROUND INFORMATION

Cost Benefit:	Increased participation in NFIP will provide flood insurance to more people in the Commonwealth.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	2,4
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	FEMA CAP-SSSE
Lead Agency/Responsible Department:	DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Workshops and course are offered to communities, non-profits (such as VFMA, APA, Silver Jackets, etc.), and professional organizations (building officials, surveyors, zoning officials, etc.) to explain the NFIP program and flood insurance.

Promote and Implement Virginia Silver Jackets Program

Mitigation Action FL-18

Continue to participate in the Silver Jackets Program across the state. The mission of Silver Jackets is to function as a catalyst in the identification and resolution of flood hazards to support the reduction of flood risk within the Commonwealth to include such items as flood observation and warning systems, planning, flood hazard mapping, flood hazard mitigation, dams, as well as flood response and recovery activities.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1,2,3,4
Category(s) Addressed:	1,2,3,4,5,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	USACE
Lead Agency/Responsible Department:	DCR, VDEM, DEQ, USACE, USGS, NOAA, FEMA, NRCS
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

The Virginia Silver Jackets team brings individuals from different agencies together to facilitate collaboration, share information, and leverage resources to identify and implement solutions to reduce flood hazards. In addition to the Army Corps of Engineers, the Virginia Team currently includes staff from VDEM, DEQ, Virginia DCR, NRCS, FEMA, NWS and USGS. The Virginia Silver Jackets team brings individuals from different agencies and fields of expertise together to facilitate communication, share information, and provide 'one-stop' for local and state governments to obtain information and identify solutions to reduce flood hazards. The Virginia Silver Jackets Team first met on June 23, 2010, and officially signed a Charter on December 22, 2010.

FEMA Risk Map Program

Mitigation Action FL-19

Support FEMA in its outreach and education efforts when rolling out the Risk Map Program.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	2,3,4
Category(s) Addressed:	1,2,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	FEMA
Lead Agency/Responsible Department:	DCR, VDEM, FEMA
Implementation Schedule:	2-3 Years
Status:	**Ongoing**

ADDITIONAL COMMENTS

FEMA's Risk Map Program has 5 goals, which include addressing gaps in flood hazard data, outreach and education, hazard mitigation planning, enhanced digital platform, and alignment and synergies.

Support Virginia Flood Risk Information System

Mitigation Action FL-20

As new data on flood risk and buildings located in the floodplain become available, ensure that it is shared so that it can be incorporated into the Virginia Flood Risk Information System.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1,2,3,4
Category(s) Addressed:	1,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	FEMA, USACE, FEMA, VDEM
Lead Agency/Responsible Department:	DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

The implementation of the Virginia FRIS site will provide the following benefits:

- Current flood hazard data and risk information, including available dam inundation zones, will be available to the public through an interactive website.
- Anyone with internet access will be able to search by address, county or political area, and view the flood hazards at the site.
- Users will be able to print a custom flood hazard map that contains the same information as a DFIRM, but allows the user to select the area that is shown within the map.

The site will be a source of maps and data for jurisdictional hazard mitigation plans.

Encourage Participation in the Community Rating System

Mitigation Action FL-21

Encourage participation in the Community Rating System (CRS), which implements higher standards for floodplain management. Participation in the CRS program can reduce NFIP flood insurance premiums for each policy holder in a community.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	CAP-SSSE, Agency Funds
Lead Agency/Responsible Department:	DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Currently, 290 of the 323 communities in the Commonwealth participate in the NFIP. Additionally, 25 communities are participating in the Community Rating System, resulting in a total statewide savings of more than $4.8 million.

Develop Flood Mitigation Workshop for Businesses

Mitigation Action FL-22

Keeping businesses open after an event is crucial to the economy and a community's recovery process. By taking steps today, risk can be reduced for the future and install resiliency and continuity for a business. VDEM will develop a pilot mitigation workshop tailored towards businesses, and how they can take steps to reduce or eliminate their risk to losses. The goal is to work with local Chamber of Commerce, Planning District Commissions, FEMA, Virginia Silver Jackets, and the Department of Conservation and Recreation to develop a pilot workshop.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	HMGP, Agency Funds, USACE
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	2 Years
Status:	**Not Started**

ADDITIONAL COMMENTS

USACE National Nonstructural Flood Proofing Committee is available to assist with flood proofing mitigation workshop. VDEM has recently hired a Flood Mitigation Coordinator who will be working to coordinate these efforts.

Continue to Encourage Communities to Increase Design Flood Elevation in Local Floodplain Ordinances

Mitigation Action FL-23

Encourage local officials to consider increasing the level of protection required for new construction and substantial improvements in the local floodplain ordinance.

BACKGROUND INFORMATION

Cost Benefit:	By increasing the level of protection for new construction and improvements, you are reducing the potential for future loss from flooding.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1,2
Category(s) Addressed:	1,5,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Undetermined
Potential Funding Sources:	Community Funds, CAP-SSSE
Lead Agency/Responsible Department:	DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Out of the 290 communities participating in the NFIP, 107 of them have at least a 1 foot freeboard requirement or higher. Included in that total, 4 communities have a 2-foot freeboard requirement, and 4 communities have a 3-foot freeboard requirement.

Post Disaster Technical Assistance and Targeting

Mitigation Action FL-24	
Work with federal partners to provide technical assistance to local communities impacted by natural events to develop mitigation actions for targeted buildings or critical infrastructure.	
BACKGROUND INFORMATION	
Cost Benefit:	Not Determined
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2,3,6
Priority (High, Medium, Low):	High
Estimated Cost:	Dependent on Scope of Assistance
Potential Funding Sources:	FEMA HMTAP, HMGP
Lead Agency/Responsible Department:	VDEM, DCR, FEMA
Implementation Schedule:	As funding becomes available
Status:	**Ongoing**
ADDITIONAL COMMENTS	
Engage with the FEMA Region III Planning team to use existing flood mapping tools to develop a repository of prioritized & refined mitigation project solutions for existing strategies. USACE has the following programs that could apply to post disaster technical assistance and targeting: Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.	

Incorporate More Detailed Building Descriptive Into VAPS Reporting Requirements

Mitigation Action FL-25

The Department of Treasury's VAPS database contains building specific information for all state owned and operated facilities. To improve the analysis of risk to these facilities, more detailed building information would be needed. The action involves working with the Department of Treasury's Risk Management Division to update the fields in the VAPS reporting database.

BACKGROUND INFORMATION

Cost Benefit:	This will improve the ability to target at risk state facilities.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	1,4
Category(s) Addressed:	2,4,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM, DCR, VTS DRM
Implementation Schedule:	2-3 Years
Status:	**Not Started- Staff Changes in Planning**

ADDITIONAL COMMENTS

By requiring building managers to include additional information on the buildings themselves, then more analysis can be done on future HIRAs.

Encourage Local Government Sponsorship of Grant Projects to Mitigate Repetitive Loss Properties

Mitigation Action FL-26

Target repetitive loss property communities with direct mailings, workshops, web-based guidance and project applications and technical support to maximize use of FEMA grant programs to mitigate targeted repetitive loss and severe repetitive loss list properties. Maximize outreach through technical workshops.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM, DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

VDEM mitigation staff has assisted local communities in developing Hazard Mitigation Assistance funds to mitigated Repetitive Loss and Severe Repetitive Loss properties. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Structural Retrofit of Existing Buildings

Mitigation Action MH-1

Previously 2013 Action 2

Assist localities, state agencies, PDCs, and eligible PNPs to identify vulnerable structures and apply for and implement structural retrofit projects. Modifications to the structural elements of a building to reduce or eliminate the risk of future damage and to protect inhabitants. The structural elements of a building that are essential to protect to prevent damage include foundations, load-bearing walls, beams, columns, building envelope, structural floors and roofs, and the connections between these elements.

BACKGROUND INFORMATION

Cost Benefit:	Due to the relative low probability of strong earthquakes and extreme winds in or around Virginia, the ability to demonstrate cost effectiveness for these projects is low.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Earthquake, Wind, Flood, Winter Weather
Goal(s) Addressed:	1
Category(s) Addressed:	2
Priority (High, Medium, Low):	Low
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMA Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

While the statewide building code addresses many of the structural requirements, older structures may not be built to current codes and require retrofits to protect against natural hazards. The City of Virginia Beach successfully implemented a project to retrofit fire stations with hurricane shutters to protect against wind damage. VDEM will continue to work with communities and state agencies to identify structures that may need to be retrofitted. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

USACE has the following programs that could apply to structural retrofit of existing buildings: Planning

Structural Retrofit of Existing Buildings

Mitigation Action MH-1

Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Non-Structural Retrofit of Existing Buildings

Mitigation Action MH-2

Previously 2013 Action 3

Assist localities, state agencies, PDCs, and eligible PNPs to identify vulnerable structures and apply for funding to implement non-structural retrofit projects. These projects involve modifications to the non-structural elements of a building or facility to reduce or eliminate the risk of future damage and to protect inhabitants. Non-structural retrofits may include bracing of building contents to prevent earthquake damage or the elevation of heating and ventilation systems.

BACKGROUND INFORMATION

Cost Benefit:	Depending on the cost, non-structural retrofits may be a more appropriate option due to the low probability of strong earthquakes. Depending on current elevation, elevating utilities above BFE may also be cost effective.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Earthquake, Flood
Goal(s) Addressed:	1
Category(s) Addressed:	2
Priority (High, Medium, Low):	Low
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMA Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Historically there have been some projects funded to raise utility systems above BFE. With regards to earthquake strapping, materials were provided to residents of the impacted areas of the Mineral Earthquake on steps to take to secure contents to prevent future damage. Outreach and education on non-residential retrofitting will continue. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Non-Structural Retrofit of Existing Buildings

Mitigation Action MH-2

USACE has the following programs that could apply to non-structural retrofit of existing buildings: Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Infrastructure Retrofit

Mitigation Action MH-3

Previously 2013 Action 4

Assist localities, state agencies, PDCs, and eligible PNPs to identify vulnerable structures and apply for funding to implement infrastructure retrofit projects. Measures to reduce risk to existing utility systems, roads, and bridges.

BACKGROUND INFORMATION

Cost Benefit:	Loss of function of a utility system can produce high benefits, but these projects are all dependent on the overall cost of mitigation.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood, Wind, Earthquake
Goal(s) Addressed:	1
Category(s) Addressed:	2
Priority (High, Medium, Low):	High
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMGP, PDM
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Many communities across the Commonwealth have applied for and received funds to mitigation infrastructure, such as generator quick connects for sewer pumping stations and shelters. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

USACE has the following programs that could apply to infrastructure retrofit: Continuing Authorities, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Soil Stabilization

Mitigation Action MH-4

Previously 2013 Action 5

Assist localities, state agencies, PDCs, and eligible PNPs to identify vulnerable structures and apply for funding to implement soil stabilization projects. These are projects to reduce risk to structures or infrastructure from erosion and landslides, including installing geo-textiles, stabilizing sod, installing vegetative buffer strips, preserving mature vegetation, decreasing slope angles, and stabilizing with rip rap and other means of slope anchoring.

BACKGROUND INFORMATION

Cost Benefit:	There is potential to provide protection to multiple structures and utilities, which is a direct benefit.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood (Erosion), Landslide
Goal(s) Addressed:	1
Category(s) Addressed:	2,3,4
Priority (High, Medium, Low):	Low
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMGP, PDM
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Soil stabilization projects require a lot of pre-engineering to identify the problem, probability of occurrence, and proposed solution. A history of erosion or slope reduction, and rate of erosion must also be quantified. While VDEM has not been directly involved in any soil stabilization projects in the Commonwealth, mitigation staff continues to work with communities to identify potential projects. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Soil Stabilization

Mitigation Action MH-4

USACE has the following programs that could apply to infrastructure retrofit: Continuing Authorities, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Post-Disaster Code Enforcement

Mitigation Action MH-5

Previously 2013 Action 6

In limited circumstances, FEMA may fund post-disaster code enforcement projects. These projects would only be eligible under HMGP. Extraordinary needs associated with enforcing local building codes during post-disaster reconstruction may include the performance of building department functions such as building inspections, and performance of substantial damage determinations under the NFIP.

BACKGROUND INFORMATION

Cost Benefit:	Ensuring that when re-building, that codes are being enforced to reduce future risk is extremely important in community recovery. It would be much cheaper to re-build correctly then retrofit later.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1,2
Category(s) Addressed:	1
Priority (High, Medium, Low):	Medium
Estimated Cost:	Dependent on Event
Potential Funding Sources:	HMGP
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Not Started
Status:	**Not Started**

ADDITIONAL COMMENTS

This project type would be dependent on a major disaster declaration in which there was extraordinary widespread damage which required post-disaster code enforcement.

HMGP 5% Initiative Projects

Mitigation Action MH-6

Previously 2013 Action 7

Assist localities, state agencies, PDCs, and eligible PNPs to identify needs and apply for funding to implement 5% initiative projects. These projects provide an opportunity to fund mitigation actions that are consistent with the goals and objectives of the state and local mitigation plans and meet all HMGP program requirements, but for which it may be difficult to conduct a standard BCA to prove cost-effectiveness. Activities may include:
The use, evaluation, and application of new, unproven mitigation techniques, technologies, methods, procedures, or products; Equipment and systems for the purpose of warning citizens of impending hazards; Purchase of permanently installed generators or related equipment, such as generator hook-ups; Hazard identification or mapping and related equipment for the implementation of mitigation activities; Geographic Information System (GIS) software, hardware, and data acquisition whose primary aim is mitigation; Public awareness or education campaigns about mitigation; and Evaluation of model building codes in support of future adoption and/or implementation.

BACKGROUND INFORMATION

Cost Benefit:	Cost effectiveness for these project types are typically cannot be determined.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1,2,3,4
Category(s) Addressed:	1,5,6,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMGP
Lead Agency/Responsible Department:	VDEM, local project sponsors
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

5% of total HMGP funding, per federal declaration, can be used to fund these projects. In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Emergency Power for Vulnerable University Facilities

Mitigation Action MH-7

Previously 2013 Action 8

Evaluate and install emergency power generators sufficient to maintain critical business and research functions within vulnerable buildings.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1
Category(s) Addressed:	5
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	University Funds, HMGP
Lead Agency/Responsible Department:	Virginia Tech, University of Virginia, University of Virginia
Implementation Schedule:	As Funding Becomes Available
Status:	**In Progress**

ADDITIONAL COMMENTS

Virginia Tech
Generator switching gear installed in four buildings. Buildings are designated as shelter areas per the Virginia state shelter plan. Further infrastructure improvements are still required.

University of Virginia
Assessment has been done with documented service needs of those buildings presently with generators. Assessment in progress of those buildings which do NOT have generators and would require them to maintain life safety.

In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Utility Replacement at University of Virginia's College at Wise

Mitigation Action MH-8

Previously 2013 Action 9

Replace overhead power lines with underground.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1
Category(s) Addressed:	1,2,5
Priority (High, Medium, Low):	
Estimated Cost:	$238,090
Potential Funding Sources:	Capital Projects, E&G and Auxiliary
Lead Agency/Responsible Department:	University of Virginia's College at Wise
Implementation Schedule:	As Funding Becomes Available
Status:	**In Progress**

ADDITIONAL COMMENTS

The status includes the placing the main electrical feed into campus via underground replacing the existing overhead line. This work is beginning this week, with a project cost of $238,090. This is the most critical component in the overall campus replacement project. This project will affect the entire campus and reduces the potential for ice to bring down power lines.

In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Electrical Wiring for Future Emergency Generator Hook-Up

Mitigation Action MH-9

Previously 2013 Action 10

Provide necessary electrical hook-up, wiring, and switches to allow readily accessible connections to emergency generators at State owned National Guard armories throughout the Commonwealth. National Guard facilities are often used by both the Guard and Localities during natural disasters such as hurricanes and major storms as command posts and places of temporary refuge. Loss of power to the building hampers emergency aid efforts and affects the safety and well-being of any occupant (military or civilian) during and after a storm event. Installation of electrical hook-up, wiring, and transfer switches to accommodate connection to an emergency generator will assure that these buildings can continue to be utilized during an emergency event.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1
Category(s) Addressed:	5
Priority (High, Medium, Low):	Medium
Estimated Cost:	$1.5 Million
Potential Funding Sources:	HMGP, Agency Funds
Lead Agency/Responsible Department:	DMA
Implementation Schedule:	As Funding Becomes Available
Status:	**In Progress**

ADDITIONAL COMMENTS

Virginia Facilities Management is currently tracking 47 Readiness Centers and 14 Field Maintenance Shops (FMS). At this time 12 Readiness Centers have operational Emergency Generators; another 4 have generators on site but have not been installed. Studies are underway for an additional 17 Readiness Centers to have generators installed in the future.

Installation of Emergency Power Systems

Mitigation Action MH-10

Previously 2013 Action 11

Install generator to provide electrical power to 5 regional animal health laboratory facilities.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1
Category(s) Addressed:	5
Priority (High, Medium, Low):	Low
Estimated Cost:	$832,000
Potential Funding Sources:	Capital Budget Request
Lead Agency/Responsible Department:	VDACS
Implementation Schedule:	As Funding Becomes Available
Status:	**Not Started**

ADDITIONAL COMMENTS

Project is dependent on funding.

Encourage the Integration of Hazard Identification and Risk Assessment Data into Other State Plans/Programs.

Mitigation Action MH-11

Previously 2013 Action 12

Incorporate the results of this State Hazard Mitigation Plan into state, local, and university COOPs, EOPs, hazard mitigation plans, etc., as needed.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	3
Category(s) Addressed:	1,7
Priority (High, Medium, Low):	High
Estimated Cost:	Agency Funds
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

The results of the HIRA are incorporated into the Commonwealth of Virginia Emergency Operations Plan (COVEOP). In addition, the HIRA provides supporting historical reference for the FEMA required THIRA. Also, the HIRA process has incorporated private infrastructure elements such as statewide pipelines that will be used as an outreach and education tool. The state HIRA is also incorporated into each local and university hazard mitigation plan.

Encourage Sharing of HIRA Data Between Local Plans and State Plan

Mitigation Action MH-12

Previously 2013 Action 13

Work with local planning district commissions to encourage the methodology used in the state HIRA to be utilized in plan updates. This allows for a consistent way to share data between local plans and state plans regarding integration. Data can be shared from local plans up to the state, and vice versa to make the process a more fluid and living planning effort.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2,3
Category(s) Addressed:	1,5,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

The action has been modified, and several local hazard mitigation plans have modeled the 2010 HIRA for their plan updates.

Promote DRU Plans to Public and Private Universities

Mitigation Action MH-13

Previously 2013 Action 14

Promote DRU plans to public universities that do not currently have DRU plans. Also, provide outreach to existing DRU plans about updating their plans. If eligible applicants apply on their behalf, private universities can also participate on the DRU process.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2
Category(s) Addressed:	1,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	HMA Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Since the 2010 plan, William and Mary University as well as Southwest Virginia Community College have received funding to develop DRU plans.

Continuity of Government Planning

Mitigation Action MH-14

Previously 2013 Action 18

Develop and establish Commonwealth Essential Functions (CEFs). Work with state agencies to identify agency Mission Essential Functions (MEFs) that directly support CEFs, and in the development of Continuity Plans to ensure essential services are available to citizens during a disaster or disruption of services.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2
Category(s) Addressed:	1,5,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	All State Agencies
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Gain Support to Incorporate Hazard Mitigation Planning into Local Comprehensive Plans

Mitigation Action MH-15

Previously 2013 Action 19

Work with Governor's office, state Secretary's and General Assembly to incorporate the hazard mitigation planning process into the local comprehensive planning process, thus working to solidify these principles and methods into planning at the local level.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2
Category(s) Addressed:	1,6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	Virginia Department of Emergency Management
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Recommendations have been provided by VDEM for legislative review and consideration over the last three legislative sessions. This remains an ongoing strategy.

Operational Security Review of Sensitive Data

Mitigation Action MH-16

Previously 2013 Action 20

As state planning documents reach final draft stages, an operational security review will be performed. Any information that is deemed to be sensitive will be identified and options explored such as removal of the material deemed sensitive from the public version of the document or establishment of an un-edited version in a secure manner.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	3
Category(s) Addressed:	1,5,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Several internal SOPs have been developed for operation security review and handling requests for secure versions of plans that are not available for public viewing.

Continued Natural Hazard Information Collection and Sharing

Mitigation Action MH-17

Previously 2013 Action 21

As events occur in the Commonwealth, develop an ongoing method to collect, organized, and analyze data as needed. Hold bi-annual meetings/conference calls to discuss improvements in data collection. Compile all data in a GIS format, when appropriate, for future revisions of the plan and distribution to other state agencies, universities, and local governments.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	3
Category(s) Addressed:	1,5,6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds, HMA Funds
Lead Agency/Responsible Department:	VDEM, DMME, DCR, DOF, VT CGIT, State Climatology Office, FEMA, USGS, NWS, USACE
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

As large events occur across the Commonwealth, data is collected among appropriate agencies. At least every five years this data is updated and incorporated into the state HIRA.

Incorporate Hazard Mitigation into Data Collection Processes for State Facilities and Assets

Mitigation Action MH-18

Previously 2013 Action 22

Identify state agencies that collect data specific to state owned and operated facilities and assets and identify ways to incorporate information needed for mitigation in their data collection process. This prevents duplication of efforts involved in creating a "centralized database" when collection and maintenance of data is already taking place. When updates for the state plan are needed, simple data acquisition can take place rather than the creation and maintenance of a separate database.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	3
Category(s) Addressed:	1,5,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	VDEM, DGS, DTRM, Other Agencies
Implementation Schedule:	Long Term
Status:	**Ongoing**

ADDITIONAL COMMENTS

No progress has been made on the original action, in large part because of limited staff, and the information would not be cost-effective to create at the statewide level for local assets. Thus, the project has been reviewed and modified.

Promote More Mitigation Strategies from State Agencies

Mitigation Action MH-19

Previously 2013 Action 23

Because of the revised HIRA, the state facility analysis was improved due to improved data. VDEM will work with DGS to provide outreach to those state agencies and promote awareness to those facility managers of the natural hazards they may be vulnerable to. The goal is to promote more strategies that involve the mitigation of state facilities.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	4
Category(s) Addressed:	1,2,3,4,5,6,7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	HMGP, PDM, FMA
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Hazard Mitigation Planning Toolkit

Mitigation Action MH-20

Previously 2013 Action 24

Update and improve on the hazard mitigation toolkit which includes various FEMA and VDEM planning and project documents, and a mechanism for reporting annually on the status of local and state mitigation strategies.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

The toolkit is available on the VDEM Website, http://www.vaemergency.gov/content/mitigation-toolkit

State Hazard Mitigation Website Maintenance

Mitigation Action MH-21

Previously 2013 Action 25

Maintain and develop a website or sub-site from VDEM to provide current information and data about the state and local hazard mitigation process. This site should include information related to local efforts, state efforts, links to hazard assessment data and methods and state and FEMA guidance on the mitigation planning process generally. Also included should be best practices for structural mitigation projects.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Discussions are occurring regarding updating information specific to recovery and mitigation on website.

Local Training on Hazard Mitigation Planning Process

Mitigation Action MH-22

Previously 2013 Action 26

Provide local training on Hazard Mitigation Planning Process (G393), and work towards improving this course in the future. Provide technical assistance to planning district commissions as they update local hazard mitigation plans.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Course G393 is typically administered 2 times a year. VDEM mitigation staff regularly attends mitigation planning meetings and provide technical assistance.

Train VDEM Divisions in Mitigation Project Development

Mitigation Action MH-23	
Previously 2013 Action 27	
Train and work with other VDEM programs/divisions to identify and describe potential mitigation projects related to their programs.	
BACKGROUND INFORMATION	
Cost Benefit:	Not Determined
MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	All
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Not Started**
ADDITIONAL COMMENTS	

Mitigation Best Practices Development

Mitigation Action MH-24

Mitigation Best Practices Development

Mitigation Action MH-24

Previously 2013 Action 28

Develop a simple method to identify and record the ongoing mitigation success stories from across the Commonwealth. Identify the critical information/data needed to show the full benefits of these actions over time.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

As projects come to completion, VDEM is constantly looking for best practices. Loss avoidance studies are excellent ways to demonstrate that mitigation works, and that the upfront investment saves money long term.

Two Loss Avoidance Studies were completed as part of the 2018 update to this plan.

Building Emergency Evacuation Program

Mitigation Action MH-25

Previously 2013 Action 29

Develop and distribute internet and compact disk based evacuation plans for all facilities managed by the Department of General Services serving approximately 5 million sq. ft. Based on the general structure, the procedures for each building would be customized to meet actual requirements using video and digital picture technology. Evacuation plans would be web-based and each agency in a facility would receive a CD/DVD version for group training sessions.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2
Category(s) Addressed:	5
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Started
Lead Agency/Responsible Department:	DGS
Implementation Schedule:	As funding becomes available
Status:	**Not Started**

ADDITIONAL COMMENTS

Implementation is dependent on funding.

Use State Facility HIRA to Attempt to Reduce Insurance Premiums for State Owned Facilities

Mitigation Action MH-26

Previously 2013 Action 30

Other states have taken advantage of state facility risk assessments to reduce insurance rates for the state. It is VDEM's strategy to coordinate with the Department of Treasury to determine how the state can lower insurance on state facilities because of facilities with low risk in the revised HIRA

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2
Category(s) Addressed:	6
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM, DTRM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Initial discussions are taking place between VDEM and DTRM.

Assessment of Inundation Hazards Related to Mining-Related Impoundments

Mitigation Action MH-27

Previously 2013 Action 31

Emergency Management (VDEM), DMME will identify and implement methods to map potential inundation hazard areas of mining-related dams and impoundments using GIS-based applications. Potential hazard areas identified by this assessment will be integrated with other dam hazards databases, as needed, and made available to the public and locality land use planning authorities for emergency planning purposes.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Dam Failure, Flood
Goal(s) Addressed:	3
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	$250,000
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	DMME
Implementation Schedule:	Short Term
Status:	**Not Started**

ADDITIONAL COMMENTS

DMME currently lacks the staff to undertake this project. The agency continues to seek sources of external funding to carry out this work.

USACE has the following programs that could apply to infrastructure retrofit: Continuing Authorities, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Enhanced Statewide Public Education Program

Mitigation Action MH-28

Previously 2013 Action 32

Increase the general public's knowledge of disaster preparedness with emphasis on hurricane through an enhanced public education program – ReadyVirginia.gov.

BACKGROUND INFORMATION

Cost Benefit:	Not determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Drought, Hurricane, Flood, Tornado, Earthquake, Solar Storm, Land Subsidence, and Winter Weather
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	Medium
Estimated Cost:	Project dependent
Potential Funding Sources:	Agency Funds, HMGP
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Virginia continues to practice a Statewide Tornado Drill each spring. The 2017 Great Southeast Shakeout has more than a quarter million Virginians registered to participate.

Encourage Analysis of Pipelines and other Critical Infrastructure in Local Hazard Mitigation Plans

Mitigation Action MH-29

Previously 2013 Action 33

VDEM staff in conjunction with Pipelines and Informed Planning Alliance (PIPA) will encourage the integration of energy pipelines and other critical infrastructure into local and state HIRAs. When critical infrastructure is impacted because of a natural hazard, it greatly impacts the community's ability to respond and recover from a disaster. Identifying potential vulnerabilities and putting forth actions to mitigate them will be critical in reducing long term risk. PIPA promotes risk-informed land use and development near transmission energy pipelines.

BACKGROUND INFORMATION

Cost Benefit:	Not determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1,2
Category(s) Addressed:	1,3,5,6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	Not determined
Potential Funding Sources:	US Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) Technical Assistance Grants (TAG)
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Official Recognition of the Virginia Hazard Mitigation Advisory Committee and Working Group

Mitigation Action MH-30

Previously 2013 Action 34

Work through the Secretary of Public Safety's Office to obtain official recognition of the Virginia Hazard Mitigation Advisory Committee.

BACKGROUND INFORMATION

Cost Benefit:	Not determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2
Category(s) Addressed:	5,6
Priority (High, Medium, Low):	High
Estimated Cost:	Not determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Continue Holding Annual HMA Grant Workshops

Mitigation Action MH-31

Previously 2013 Action 35

Continue holding annual HMA grant workshops in concurrence with the annual HMA application period. These workshops focus on the 3 HMA grant programs and how to build a strong application. The location of these workshops is determined by each VDEM region. If there are HMGP funds available, HMA workshops will be worked into HMGP briefings through webinar.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	High
Estimated Cost:	$1,000 per workshop
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Due to the number of disasters in 2016 and 2017, annual HMA grant workshops were not held. However, VDEM grants staff undertook a stakeholder engagement and peer review process in 2017 which was the focus of the outreach strategy. Annual workshops are being scheduled for April and May of 2018. These workshops are geared towards helping local governments understand the HMA programs and how they can benefit from them. The VDEM website is being updated for the 2018 cycle, and VDEM has re-vamped their application process to move from paper applications to our grants management portal Mitigationva.org. In the past, VDEM has found that many project submissions result from discussions had at the annual workshops. There will be one in each of the 7 regions in 2018. The goal in 2018 is to obtain more complete applications, and the electronic submission will assist greatly with that. In addition to the regional meetings, VDEM will host webinars to walk through the grants portal submission process. VDEM is also opening up the HMA cycle earlier in 2018 to allow for more time for applicants to develop their applications.

Encourage Analysis of Emergency Preparedness for Pipeline Emergencies in State and Local Hazard Mitigation Plans

Mitigation Action MH-32

Previously 2013 Action 36

Recent pipeline incidents have highlighted the need for communities to be adequately prepared for pipeline emergencies. An investigation of several incidents revealed that the local emergency responders were not adequately prepared to respond to the pipeline emergency. VDEM staff in conjunction with US Department of Transportation Pipeline and Hazardous Material Safety Administration (PHMSA) will review Virginia's emergency preparedness to respond to energy pipeline failures at the state level. Local HIRAs are encouraged to review their local capability to respond to energy pipeline emergencies. Identifying potential vulnerabilities and putting forth actions to prepare an effective response to them will be critical in reducing long term risk.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1,2
Category(s) Addressed:	1,3,5,6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	US Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) Technical Assistance Grants (TAG)
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Encourage Analysis of Emergency Preparedness for Pipeline Emergencies in State and Local Hazard Mitigation Plans

Mitigation Action MH-32

Develop Hazard Mitigation Plan Database Tool

Mitigation Action MH-33

Develop a Hazard Mitigation Planning database tool that would allow users to enter and track HMP information such as annualized damages, capabilities, repetitive losses, hazards information, and mitigation strategies.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2,3,4
Category(s) Addressed:	1
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

Develop Hazard Mitigation Plan Database Tool

Mitigation Action MH-33

Joint Commonwealth of Virginia / Federal Agency Data Format Pilot Initiative

Mitigation Action MH-34

Develop a joint Commonwealth of Virginia and federal agency data format pilot initiative. This is an effort to streamline data sharing and utility.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2,3,4
Category(s) Addressed:	1
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

Joint Commonwealth of Virginia / Federal Agency Data Format Pilot Initiative
Mitigation Action MH-34

Implement a comprehensive mitigation component (406) into the Public Assistance Program to maximize the impact of post-disaster funding to reduce the likelihood of future losses.

Mitigation Action MH-35

Identify a percentage of Public Assistance funds for Virginia that would be the target goal for 406 Mitigation. The national average is 3 cents per dollar on PA funds, the goal is to increase that for Virginia and determine at a high level what that number should be for every federal declaration.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	2,3,4
Category(s) Addressed:	1
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Virginia Department of Historic Resources -Update, maintain, and distribute information regarding protection, mitigation, identification, and repair of historic assets before and after disasters.

Mitigation Action MH-36

Identify publications and programs that are needed to assist communities and property owners with protection, mitigation, and repair/restoration of historic assets, and that will assist communities and property owners with identifying potential historic resources.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	All
Goal(s) Addressed:	1,2,3,4
Category(s) Addressed:	1, 2, 3, 6, 7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds, Grant Funds
Lead Agency/Responsible Department:	DHR
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Wildfire Mitigation

Mitigation Action WF-1

Assist localities, state agencies, PDCs, and eligible PNP's to identify vulnerable structures and apply for funding to implement wildfire mitigation projects. These are projects to mitigate the risk to at-risk structures and associated loss of life from the threat of future wildfire through:

- Defensible Space for Wildfire
- Application of Ignition-resistant Construction
- Hazardous Fuels Reduction

BACKGROUND INFORMATION

Cost Benefit:	Wildfire mitigation projects generally have proven to be cost effective, due to the relatively low cost to implement.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Wildfire
Goal(s) Addressed:	1
Category(s) Addressed:	2
Priority (High, Medium, Low):	Medium
Estimated Cost:	Project Dependent
Potential Funding Sources:	HMGP, PDM
Lead Agency/Responsible Department:	VDEM and DOF
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

VDEM and DOF are working closely together to identify a community for a pilot project for wildfire mitigation funding. The idea is that if one community can be used as an example in Virginia, then other communities will take notice and interest. This project type is voluntary, and requires written voluntary participation agreements from property owners. Individual property owners cannot apply directly to FEMA, they are required to work through their community or other eligible entity as a sponsor.

In instances where federal funds, licenses, or permits are involved, consultation with DHR/SHPO is necessary pursuant to Section 106 of the National Historic Preservation Act, as alterations to historic properties may jeopardize their historic status. Unauthorized alterations may jeopardize funding.

Training for Virginia's Fire Service

Mitigation Action W-2

To continue ongoing fire and emergency services to over 800 fire and EMS departments across the Commonwealth. VDFP is the only accredited entity for training Virginia's Fire Service. VDOF provides annual training on wildfire suppression and advanced incident management, to increase the capacity of Virginia's fire service.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Wildfire
Goal(s) Addressed:	4
Category(s) Addressed:	5,6
Priority (High, Medium, Low):	Low
Estimated Cost:	$2.1 Million
Potential Funding Sources:	Fire Programs Fund
Lead Agency/Responsible Department:	VDOF; VDFP
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

The Department of Fire Programs (VDFP) continues to provide Pro Board accredited training to Virginia's fire services community. In doing so, the Agency continues to strengthen the preparedness of Virginia's localities in the event of a man-made or natural disaster. The Virginia Department of Forestry (VDOF) provides more than 11,000 annual class hours of wildfire suppression and advanced incident management training to increase capacity in Virginia's fire service.

Landslide Hazard Mapping Program

Mitigation Action G-1

Landslide hazard maps are needed in Virginia to identify high risk areas for emergency and land use planning purposes. Provide GIS-based maps that identify areas at higher risk for damage from landslides, including debris flows, suitable for emergency and land use planning purposes. Mapping will target areas with a high susceptibility to landslides. Work will be prioritized by locality based on overall VDEM landslide hazard ranking.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Landslide
Goal(s) Addressed:	3
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	$16 Million
Potential Funding Sources:	Not Determined, HMGP 5%
Lead Agency/Responsible Department:	DMME
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Pilot project for landslide mapping underway in Page County. This project was funded through HMGP 5% initiative funds for DR 1874.

Delineation of Watersheds & Recharge Areas for Karst Aquifers in VA and Compilation of GIS-based Comprehensive Karst Hydrology for Virginia

Mitigation Action G-2

The VA DCR Karst Program is engaged in a project to delineate watersheds and define recharge areas for karst aquifers in VA. A GIS-based VA Karst Hydrology Atlas is being completed detailing karst groundwater dye tracing investigations. The current Karst Program dye tracing work is to produce data to provide a hydrologic basis for defining conservation site boundaries for VA's significant caves. Given significant resources, it would be desirable to perform hydrologic investigations including extensive groundwater dye tracing throughout VA's karst areas. If it was available, knowledge of underground flow paths would be invaluable information for planning and for emergency services personnel in the event of a hazardous material event in VA's karst lands.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Karst
Goal(s) Addressed:	3
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	DCR Division of Natural Heritage
Implementation Schedule:	As Funding Becomes Available
Status:	**Ongoing**

ADDITIONAL COMMENTS

This action item is still relevant and a viable option, but is highly dependent on funding to implement.

Karst Hazard Mapping Program

Mitigation Action G-3

Assessments conducted by DMME of known karst and sinkhole locations are currently available only in a non-digital format and at scales that are inadequate for site-specific decision making. There is a substantial need to complete the geologic mapping, digital conversion, and quality assurance of this data. Working in cooperation with the DCR Natural Heritage Karst Program, DMME will complete the digital conversion of currently available karst and sinkhole location maps to digital products using GIS-based mapping applications. Derivative maps will also be produced that delineate the relative susceptibility to karst development and related hazards of mapped carbonate bedrock formations in the Valley and Ridge physiographic province.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Karst
Goal(s) Addressed:	3
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	$650,000
Potential Funding Sources:	Not Determined, possibly HMGP 5% Initiative
Lead Agency/Responsible Department:	DMME, and DCR
Implementation Schedule:	As Funding Becomes Available
Status:	**In Progress**

ADDITIONAL COMMENTS

The existing DMME sinkhole dataset has been converted to GIS format and QA/QC has been completed. A project plan and funding are still needed to develop karst susceptibility and related hazards maps.

GIS Fault Mapping of Central Virginia Seismic Zone

Mitigation Action G-4

This project will use historical data, published reports, terrain analysis and new mapping to identify faults that cause earthquakes in the west half of the Central Virginia Seismic Zone. Communities and infrastructure at risk of future damage will be identified. Results will be provided in GIS format to affected communities. Results will also be incorporated into future State and local HIRAs.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Earthquake
Goal(s) Addressed:	3
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	High
Estimated Cost:	$300,000
Potential Funding Sources:	Not Determined, possibly HMGP 5% Initiative
Lead Agency/Responsible Department:	DMME
Implementation Schedule:	As Funding Becomes Available
Status:	**Complete**

ADDITIONAL COMMENTS

Through the Hazard Mitigation Grant Program, funding was secured to map the CVSZ, and the analysis was incorporated into this version of the plan as well as regional plan updates.

Comprehensive Dam Information Database Development

Mitigation Action DF-1

Identify and convene committee to identify, coordinate and collect relevant data for use in a single comprehensive database of all dams located in or affecting the Commonwealth of Virginia.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood, Dam Failure
Goal(s) Addressed:	3,4
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	DCR, USACE
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

USACE maintains the National Inventory of Dams, and DCR Division of Dam Safety and Floodplain Management provide data from Virginia.

DCR is already working on creating the Dam Safety Inventory System, which is an online database. DSIS is already live, but it is still having data added to it, so it's not openly available to the public at this time.

USACE has the following programs that could apply to assessment of inundation hazards related to mining-related impoundments: Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Dam Inundation Areas Mapping and Risk Assessment

Mitigation Action DF-2

Identify and implement a method to map and assess the hazards of dam inundation areas in the Commonwealth of Virginia. Will require protection of sensitive data as completed

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Flood, Dam Failure
Goal(s) Addressed:	3,4
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Dam Owners
Lead Agency/Responsible Department:	DCR
Implementation Schedule:	Ongoing
Status:	**Ongoing**

ADDITIONAL COMMENTS

Regulated dam owners are now required to perform downstream dam inundation modeling. Since this is based on individual dam owners, this is an ongoing process.

DCR is already working on creating the Dam Safety Inventory System, which is an online database. DSIS is already live, but it is still having data added to it, so it's not openly available to the public at this time.

USACE has the following programs that could apply to comprehensive dam information database development: Planning Assistance to States, Flood Plain Management Services, and Silver Jackets. Those interested should

Dam Inundation Areas Mapping and Risk Assessment

Mitigation Action DF-2

contact the applicable USACE District office to get more information on program details and requirements, completed and/or ongoing projects or studies, and/or requesting a new project or study.

Install Fire Alarm and Sprinkler Systems at DBHDS Facilities

Mitigation Action HC-1

Previously 2013 HC-7

Install automatic fire sprinkler and fire alarm systems throughout these buildings.

BACKGROUND INFORMATION

Cost Benefit:	246 patients and staff are protected by this action.

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Human Caused
Goal(s) Addressed:	1
Category(s) Addressed:	2
Priority (High, Medium, Low):	Low
Estimated Cost:	$127,150,000
Potential Funding Sources:	Virginia Public Building Authority Bonds and local leveraging
Lead Agency/Responsible Department:	DBHDS
Implementation Schedule:	2 years
Status:	**In Progress**

ADDITIONAL COMMENTS

Western State Hospital - A project for the replacement of Western State Hospital is approximately 65% complete. Project completion and occupancy is scheduled for September/October 2013.

Central Virginia Training Center - This project involves the installation of fire alarm and sprinkler systems in approximately 10 buildings. The fire alarm system has been replaced facility-wide. Emergency generators have been installed in 5 buildings. Renovations have been accomplished in one building to relocate patients from a non-code compliant building. Sprinkler systems are being installed as a part of total building renovations, and have been completed in three buildings. Design is underway for the total renovation of a fourth building.

Northern Virginia Training Center - 5 Buildings were mitigated, protecting 135 facility residents and staff. Awaiting legislative funding on two remaining buildings.

Install Fire Alarm and Sprinkler Systems at DBHDS Facilities

Mitigation Action HC-1

Improve Fire Safety in University Buildings

Mitigation Action HC-2

Previously 2013 HC-8

Evaluate existing buildings with unenclosed multi-story stairwells to determine if enclosure of the stairwells and/or sprinkling would assure an adequate level of fire safety; once study is completed, implement retrofits on prioritized basis.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Human Caused
Goal(s) Addressed:	1
Category(s) Addressed:	2
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined and Building Specific
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	State Universities
Implementation Schedule:	As Funding Becomes Available
Status:	**Modified - Ongoing**

ADDITIONAL COMMENTS

Virginia Tech - There are still many campus buildings that have unenclosed stairways and need sprinkler systems. One building has had a fire alarm system installed in 2012. Four buildings have had fire alarm systems upgraded or expanded and 2 other buildings that had fire alarm systems that needed upgrade are in the process of capital renovation that includes installation of code compliant fire alarm systems. 28 campus buildings still have no fire alarm systems. VHMAC recommended combining the three actions into a general university wide action item.

Virginia Mine Mapping System

Mitigation Action HC-3

Previously 2013 HC-10

The Virginia Mine Mapping System is a database catalogue and geographic information system that serves as a highly effective tool for visualizing and analyzing underground mine workings that are keyed to specific coal beds in a spatially geo-referenced framework. Using the high spatial resolution of stratigraphic information contained in 30,000 mine maps and over 6,000 geophysical well logs from the Southwest Virginia Coalfields, DMME will digitize and integrate this information to improve the elevation control on the underground mine extents. These improvements will enable the database to serve as a tool for reducing the risks associated with living or working near abandoned underground coal mines.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Human-Caused, Karst
Goal(s) Addressed:	3
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	$600,000
Potential Funding Sources:	Not determined
Lead Agency/Responsible Department:	DMME
Implementation Schedule:	As Funding Becomes Available
Status:	**In Progress**

ADDITIONAL COMMENTS

DMME continues to scan and geo-reference coal mine maps as they become available. Through a National Coal Resource grant, DMME is also adding to the database of coal thicknesses and elevations in southwest Virginia. DMME has also scanned several hundred geophysical logs through the National Geologic and Geophysical Data Preservation grant program. Placement of these layers into an accurate three-dimensional model is still needed. The agency is actively seeking funding to continue this project.

Statewide Inventory of Abandoned Mines and Quarries

Mitigation Action HC-4

Previously 2013 HC-11

Abandoned mines and quarries in many parts of Virginia have not been accurately located or assessed for hazard potential. A thorough inventory is needed to prioritize reclamation activities aimed at mitigating risks to citizens. Complete a statewide inventory of abandoned mining sites and provide location and hazard information to emergency planners and responders and other interested parties in a GIS-based information delivery system.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Human Caused
Goal(s) Addressed:	3
Category(s) Addressed:	6,7
Priority (High, Medium, Low):	Low
Estimated Cost:	$975,000
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	DMME
Implementation Schedule:	As Funding Becomes Available
Status:	**In Progress**

ADDITIONAL COMMENTS

DMME has recorded a partial inventory of abandoned mines in the Commonwealth, but the inventory is not complete. Not all abandoned mines have been thoroughly cataloged, and some of the locations of mines in the existing inventory are of questionable accuracy, as they were located before the agency began using GPS technology. Not all sites have been assessed for their risk to public safety. This work continues with one grant-funded staff person, but the work will take decades at this rate and with this level of resources. The agency continues to seek sources of external funding to complete this work.

Newsletter to Virginia Food Industry on Food Security

Mitigation Action HC-5

Previously 2013 HC-12

The Food Safety and Security Program, Office of Dairy and Foods, will continue to distribute a bi-annual newsletter to Virginia's food industry. The newsletter addresses issues that should be helpful for the food industry to develop protocols for providing protection of food supply.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Human-Caused
Goal(s) Addressed:	4
Category(s) Addressed:	6
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Agency Funds
Lead Agency/Responsible Department:	VDACS
Implementation Schedule:	Ongoing
Status:	**Not Started**

ADDITIONAL COMMENTS

The newsletter is currently inactive and is not being sent out to the industry. The position responsible for creating and disseminating the newsletter is vacant and there is no one to produce and distribute the newsletter. We plan to resume creating and disseminating the newsletter to the industry if and/or when we can fill the position.

To reduce the impacts of communicable diseases by advancing surveillance, epidemiology, and laboratory science and service practice.

Mitigation Action CD-1

The Virginia Department of Health continues to support the monitoring, preventive measures, and public education of communicable diseases to mitigate the impact of pests and pathogens. Strengthen the existing programs, including infectious disease surveillance, laboratory detection, and epidemiologic investigation. These three core activities create and sustain a flexible, multi- purpose Virginia public health system that reduces endemic diseases and is ready and able to respond to new threats. Virginia utilizes a passive disease surveillance system (VEDSS) as a primary tool for monitoring the health of communities. This system relies on healthcare providers, laboratories, and other entities required by the Code of Virginia to provide information to local health departments for all reportable conditions in the Commonwealth.

Mitigation Strategies:

- Capacity for epidemiological investigations to understand risk factors for disease acquisition, severity
- Enhanced Surveillance systems – for disease morbidity, mortality, complications, hospitalization rates, outcomes
- Laboratory testing services – related to the collection, transport, and analysis of biological specimens to diagnose cases

BACKGROUND INFORMATION

Cost Benefit:	Not Determined – disease dependent

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Communicable Disease
Goal(s) Addressed:	1, 3, 4
Category(s) Addressed:	1, 6, 7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	CDC, HMA, Agency
Lead Agency/Responsible Department:	Virginia Department of Health
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

To reduce the impacts Flu Pandemic

Mitigation Action CD-2

The pandemic mitigation of Virginia Department of Health framework is based upon an early, targeted, layered application of multiple partially effective non-pharmaceutical measures (NPIs). The three major goals of mitigating a community-wide epidemic through NPIs are 1) delay the exponential increase in incident cases and shift thee pandemic curve to the right in order to "buy time" for production and distribution of a well-matched pandemic strain vaccine, 2) decrease the epidemic peak, and 3) reduce the total number of incident cases and, thus, reduce morbidity and mortality in the community.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Communicable Disease
Goal(s) Addressed:	1, 3, 4
Category(s) Addressed:	1, 6, 7
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	CDC, HMA, Agency
Lead Agency/Responsible Department:	Virginia Department of Health
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

Public education for communicable diseases

Mitigation Action CD-3

VDH conducts hazard mitigation education programs on regular basis for the public using a variety of methods including but not limited to distributing information such as clinician letters to healthcare providers and brochures to community groups (e.g., neighborhood associations, civic associations, parent-teacher organizations at public schools, church groups, etc.). Use Social Networks (i.e., Twitter, Facebook, etc.) and the VDH's website to get the message out.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Communicable Disease
Goal(s) Addressed:	1, 3, 4
Category(s) Addressed:	6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	CDC. HMA, Agency
Lead Agency/Responsible Department:	Virginia Department of Health
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

Drinking water and food emergencies

Mitigation Action CD-4

VDH environmental surveillance primarily includes surveillance of food and drinking water, which will primarily be coordinated by the Offices of Drinking Water (ODW) and Environmental Health Services (OEHS).

Mitigation Strategies:

- Environmental inspections and investigations of food service, food production, and manufacturing establishments
- Collection of clinical and environmental food specimens, with submission of isolates for serotyping, PFGE and other more specific testing at public health reference laboratories
- Restriction of food handlers from workplace and/or closure of food service establishments

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Communicable Disease
Goal(s) Addressed:	1, 3, 4
Category(s) Addressed:	1, 3, 5, 6
Priority (High, Medium, Low):	High
Estimated Cost:	Not Determined
Potential Funding Sources:	CDC, Agency
Lead Agency/Responsible Department:	Virginia Department of Health
Implementation Schedule:	Ongoing
Status:	**New**

ADDITIONAL COMMENTS

Identify electronic data storage needs

Mitigation Action S-1

Identify alternate electronic data storage needs.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Solar Storm
Goal(s) Addressed:	1,4
Category(s) Addressed:	1,6
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	VITA, VDEM
Implementation Schedule:	3-5 years
Status:	**New**

ADDITIONAL COMMENTS

Identify which functions are most critical for both normal electric power grid operation and recovery operations and then determine which components are essential to ensuring those functions will survive.

Solar Storm - COOP Functions

Mitigation Action S-2

Identify which functions are most critical for both normal electric power grid operation and recovery operations and then determine which components are essential to ensuring those functions will survive.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Solar Storm
Goal(s) Addressed:	1
Category(s) Addressed:	1,6
Priority (High, Medium, Low):	Medium
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	VDEM
Implementation Schedule:	3-5 years
Status:	**New**

ADDITIONAL COMMENTS

Identify which functions are most critical for both normal electric power grid operation and recovery operations and then determine which components are essential to ensuring those functions will survive.

Solar Storm – Power Grid Vulnerability Assessment

Mitigation Action S-3

Work with electric power providers to assess the vulnerabilities in the electric power grids to solar and geomagnetic storms, and the potential service impacts of these storms.

BACKGROUND INFORMATION

Cost Benefit:	Not Determined

MITIGATION ACTION DETAILS

Hazard(s) Addressed:	Solar Storm
Goal(s) Addressed:	1
Category(s) Addressed:	1,6
Priority (High, Medium, Low):	Low
Estimated Cost:	Not Determined
Potential Funding Sources:	Not Determined
Lead Agency/Responsible Department:	VDEM, SCC
Implementation Schedule:	3-5 years
Status:	**New**

ADDITIONAL COMMENTS

5.6 Virginia Risk Reduction Priorities

In May 2017, agencies of the Commonwealth and FEMA held a risk reduction consultation session, to strategize about the use of resources to enable efficient collaboration on programs, project delivery, and risk reduction. Participants discussed priorities, evaluated the status of reaching those priorities throughout the year, and tried to identify the best way to leverage existing resources for implementation. Attendees at this meeting included representatives from:

- Virginia Department of Conservation and Recreation
- Virginia Department of Emergency Management
- Virginia Department of Mines, Minerals, and Energy
- Virginia Municipal League
- Federal Emergency Management Agency
- US Army Corps of Engineers
- Resilience Action Partners

From this meeting, the following risk reduction priorities were established for the Commonwealth:

1. Develop a strategic umbrella for collaboration with other agencies.
2. Develop, integrate, and utilize data to inform analytical decision making for risk between state agencies.
3. Identify all funding sources and opportunities to leverage public funds to maximize community impact and increase resiliency.
4. Provide education, build capacity, and leverage existing relationships with planning district commissions and localities to utilize data systems and available funding sources.
5. Develop a whole community approach to empowering messaging, outreach, and education to reduce vulnerability.

These priorities are in line with the overall goals and priorities established in this plan, and will be evaluated and worked toward in the future. Future updates to this plan will be able to compare the progress on these priorities with the overall progress of the Commonwealth towards increased vulnerability reduction and risk resiliency.

Disaster Mitigation Act of 2000

§201.4(c)(4) A section on the Coordination of Local Mitigation Panning that includes the following:

(i) A description of the State process to support, through funding and technical assistance, the development of local mitigation plans;

(ii) A description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan; and
(iii) Criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs, which should include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures. Further, that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.

6.1 Local Hazard Mitigation Plan Development

This chapter provides details on funding for hazard mitigation plans, original plan development, plan updates, as well as technical assistance provided by VDEM and other agencies participating in the Advisory Committee and the Working Group.

To support the development of local hazard mitigation plans, VDEM provides assistance to local and regional jurisdictions through several mediums, including interim guidance, training materials, and Pre-Disaster Mitigation (PDM) funding for plan development became available during spring, 2002.

At that time, VDEM staff in partnership with the Department of Conservation & Recreation's Floodplain Management Program (DCR) and FEMA began an aggressive campaign to initiate local hazard mitigation planning. Table 6.1-1 provides an overview of planning activity from 2002-2006 in the Commonwealth.

Table 6.1-1 – Local Hazard Mitigation Plan Overview 2002-2006

Year	Activity
2002	PDM and FMA funding was provided to six regional planning commissions located in southwest Virginia, the Roanoke Valley, and the Central Shenandoah Valley.
2003	Created and delivered planning workshops, developed local planning assistance guidance, etc.
2003	PDM, FMA, and HMGP funding was provided to three regional planning districts and two universities: Rappahannock-Rapidan, Northern Virginia, Middle Peninsula, Virginia State University, and Radford University.
2003	HMGP from Hurricane Isabel funded 12 regional planning district plans: Accomack-Northampton, Richmond Regional, CRATER, Northern Neck, Region 2000, West

Year	Activity
	Piedmont, George Washington Regional, Thomas Jefferson, the Peninsula, Southside Hampton Roads, and Northern Shenandoah Valley. In addition, two county plans (Southampton and Amelia) and one single jurisdiction plan (City of Franklin) were funded.
2004	Two single jurisdiction plans were developed, City of Chesapeake and City of Poquoson; both were self-funded.
2005	PDM funded the George Mason University HMP.
2006	PDM and HMGP funded HMPs for the University of Virginia, Virginia Commonwealth University, and University of Mary Washington respectively.

Virginia currently has 20 local hazard mitigation plans that have been submitted and approved by VDEM and FEMA Region III. There are nine plans that either have expired or will expire in 2017, and another six that will expire in 2018. Most of these are currently being revised or will soon be revised, once funding is secured. Please see table 6.1-2 for current plan status.

Table 6.1-2 – Local Hazard Mitigation Plan Status

Plan Name	Current Plan Expiration Year	Status
Accomack-Northampton Planning District	2017	Approved
Commonwealth Regional	2017	In review (FEMA)
Central Shenandoah Planning District Commission	2018	Funding pending (DR-4291)
Cumberland Plateau Planning District Commission	2018	Will seek funding (PDM FY17)
George Washington Regional Commission	2017	In review (FEMA)
Hampton Roads Planning District Commission	2022	Approved
LENOWISCO Planning District Commission	2019	Will seek funding (PDM FY17)
Middle Peninsula District Commission	2022	Approved
Mount Rogers Planning District Commission	2017	Update in progress / funding secured (PDM FY16)
New River Valley Planning District Commission	2017	In review (FEMA)
Northern Neck Regional Planning Commission	2017	In review (FEMA)
Northern Shenandoah Valley Regional Commission	2018	Update in progress / funding secured (PDM FY15)
Northern Virginia	2022	Approved
Rappahannock-Rapidan Regional	2017	Update in progress / funding

Plan Name	Current Plan Expiration Year	Status
Commission		secured (PDM FY16)
Region 2000	2018	Funding pending (DR-4262)
Richmond-Crater Regional Planning Commission	2017	In review (FEMA)
Roanoke Valley-Alleghany Regional Commission	2018	Funding pending (DR-4262)
Southside Planning District	2018	Funding pending (DR-4262)
Thomas Jefferson Planning District Commission	2017	Update in progress / funding secured (PDM FY15)
West Piedmont Planning District Commission	2022	Approved

It is not possible to predict when and where the next disaster will strike, so VDEM mitigation staff has worked diligently to promote mitigation planning for each local jurisdiction in the Commonwealth. Not only is it important for local communities to develop and implement their mitigation plans, it is also a federal requirement for FEMA Hazard Mitigation Assistance (HMA) grant programs. HMA programs are discussed in more detail in Chapter 4, Capability Assessment.

6.2 Defining the local planning jurisdictions

One of the key issues facing the Commonwealth as it started the mitigation planning process was to define 'locality' sufficiently to meet current FEMA standards. The definition of a 'locality' provided in the DMA2K regulations was written to encompass the broad variety of community types across the US. As such, it was much broader than Virginia's political organization. In order to simplify the planning process as much as possible, the FEMA and Virginia regulatory definitions were researched and a Virginia-specific definition of those communities that would be required to take part in the hazard mitigation planning process was developed. The basis of the DMA2k local government definition is the National Flood Insurance Program definition of a 'locality.[1] It is FEMA Region III's position that the definition of a locality responsible for development of a hazard mitigation plan is:

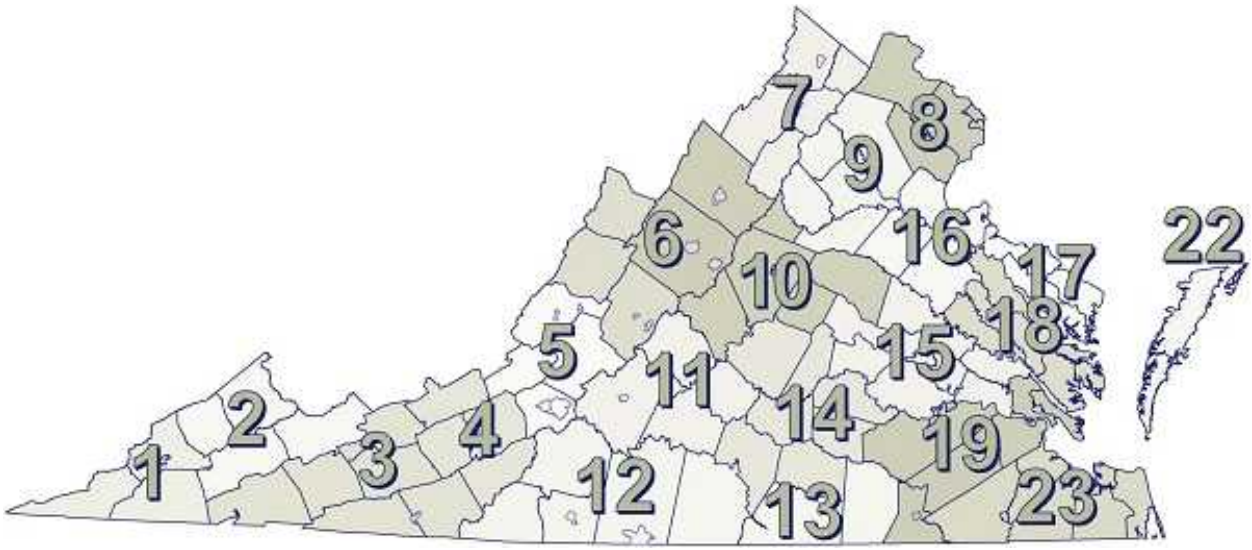
Any area or political subdivision within the Commonwealth of Virginia as defined by the Code of Virginia that has authority to create, adopt and/or enforce land use, zoning, or subdivision ordinances and regulations for the areas within its boundaries.

Within the Commonwealth of Virginia, this definition encompasses the counties, cities, and incorporated towns recognized by the *Code of Virginia*. Virginia counties, cities, and incorporated towns have independent land use management authority within their respective boundaries. The Planning District Commissions (PDC) are regional planning organizations that provide technical and planning support to the localities within their respective regions. They are an excellent resource for mitigation plan development as they have a grasp on local planning initiatives. However, while the PDCs do perform land use planning at the request of their localities, they cannot implement or enforce the plans they create for those localities. Implementation and enforcement remain the responsibility of the cities, counties, and towns for which plans were developed.

The definition also includes any federally-recognized Native American tribes. Currently, Virginia has one such tribe, the Pamunkey Indian Tribe, which received federal recognition in 2016. The reservation comprises approximately 1,200 acres and is the oldest inhabited Indian reservation in America.[2]

The Commonwealth of Virginia recognizes 38 independent cities, 95 counties, and 190 incorporated towns. There also are 21 planning district commissions in Virginia. Based on the DMA2k regulations and the locality definition provided previously, each of Virginia's cities, counties, and towns are required to develop or take an active role in the development of a hazard mitigation plan for eligibility for HMA funds. The PDCs are not required to develop a separate hazard mitigation plan for their regions, as they do not have the enforcement authority of the cities, counties, and incorporated towns. However, it has been the practice of the Commonwealth to combine as many of the mitigation plans as possible into regional, multi-jurisdictional plans using the PDCs as the planning agency for these efforts. Figure 6.2-1 identifies the 21 Planning District Commissions.

Figure 6.2-1: Planning District Commissions



6.3 Local Funding for Mitigation Planning

Funding of the development or update of a local hazard mitigation plan or disaster resistant university plan is an eligible activity under the Pre-Disaster Mitigation (PDM) program, Hazard Mitigation Grant Program (HMGP), and Flood Mitigation Assistance (FMA). FMA planning funds can only be used to update the flood section of the hazard mitigation plan. These grant programs have cost shares ranging from 0% non-federal share to 25% non-federal share. These three programs have had a significant impact on the status of local mitigation plans. Without these funding opportunities, there would be a substantial decrease in the amount of FEMA approved local hazard mitigation plans and disaster resistant university plans.

By February 2007, all localities within the Commonwealth had a FEMA approved and adopted hazard mitigation plan. As of the last update to this plan, there were also ten disaster resistant university plans in the Commonwealth. Local hazard mitigation plans and DRU plans must be updated every five years; therefore, localities have applied for funding mostly through available HMGP and PDM funds. Table 6.3-1 provides details of open or pending HMA grants to update hazard mitigation plans:

Table 6.3-1 – Local Hazard Mitigation Plan Funding Sources

Plan Name	Current Plan Expiration Year	Funding Source for Update (current or most recent)
Accomack-Northampton Planning District	2017	HMGP – DR-4092
Commonwealth Regional	2017	PDM FY14

Plan Name	Current Plan Expiration Year	Funding Source for Update (current or most recent)
Central Shenandoah Planning District Commission	2018	HMGP – DR-4291 (pending award)
Cumberland Plateau Planning District Commission	2018	PDM FY17 (pending application)
George Washington Regional Commission	2017	PDM FY15
Hampton Roads Planning District Commission	2022	HMGP – DR-4072
LENOWISCO Planning District Commission	2019	PDM FY17 (pending application)
Middle Peninsula District Commission	2022	NA
Mount Rogers Planning District Commission	2017	PDM FY16
New River Valley Planning District Commission	2017	PDM FY15
Northern Neck Regional Planning Commission	2017	PDM FY16
Northern Shenandoah Valley Regional Commission	2018	PDM FY15
Northern Virginia	2022	PDM FY15 (declined funding)
Rappahannock-Rapidan Regional Commission	2017	PDM FY16
Region 2000	2018	HMGP – DR-4262 (pending award)
Richmond-Crater Regional Planning Commission	2017	PDM FY15
Roanoke Valley-Alleghany Regional Commission	2018	HMGP – DR-4262 (pending award)
Southside Planning District	2018	HMGP – DR-4262 (pending award)
Thomas Jefferson Planning District Commission	2017	PDM FY15
West Piedmont Planning District Commission	2022	PDM FY14

FEMA, the Commonwealth of Virginia, and local planning grant sub-recipients have contributed over $2.5 million dollars since 2010 to develop and revise local hazard mitigation plans in the Commonwealth. This displays the commitment of all entities to effectively identify local risks and develop cost-effective actions to break the cycle of repetitive damages. A distribution of annual funds and cost shares can be found in Table 6.3-2.

Note that historically the Commonwealth has provided sum-sufficient funds to assist only when there is a presidentially declared disaster, and the HMGP is available.

Table 6.3-2 – Local Hazard Mitigation Plan Status

Table 6.3-2 Funding for Local Plans and DRUs				
Funding Source	**Local Share**	**State Share**	**Federal Share**	**Award Amount**
PDM FY10	$186,765	$0	$560,295	$747,060
HMGP (DR-1874)	$11,995	$47,979	$179,923	$239,897
HMGP (DR-1905)	$13,250	$53,000	$198,750	$265,000
PDM FY14	$41,697	$0	$124,970	$166,667
PDM FY15	$89,728	$0	$263,648	$353376
PDM FY16	$69,250	$0	207,750	$277,000
HMGP (DR-4042)	$6,250	$25,000	$93,750	$125,000
HMGP (DR-4072)	$13,343	$53,370	$200,139	$266,852
HMGP (DR-4092)	$6,666	$26,666	$100,000	$133,332
Total	**$438,944**	**$206,015**	**$1,929,225**	**$2,574,184**

6.4 Prioritizing Funding for Local Hazard Mitigation Plans

It is essential to prioritize funding for local hazard mitigation plan revisions to ensure that all local jurisdictions that are at risk remain eligible to apply for funds through FEMA's HMA programs. The prioritization criteria from the previous plan were reviewed and remain the same.

1. **Expiration Date**: It is VDEM's goal that all local jurisdictions on the Commonwealth remain eligible for HMA funds to reduce risk and assist in maintaining critical societal functions. Local hazard mitigation plans that expire sooner will be given priority over plans that expire at a later date.
2. **Hazard History and Probability:** Localities/Regions that are located in a geographic area that has experienced a long history of events and damages will more than likely experience similar events in the near to distant future. These jurisdictions are therefore more vulnerable to damages from future events and therefore should be given priority over jurisdictions that do not have as high of a risk.

3. **Population and Population Growth**: Localities/Regions that have a higher population are at a higher risk of injuries and fatalities should a disaster occur. Also, where there is greater population there is more infrastructures that could potentially sustain damages. The Commonwealth's mitigation vision is to reduce the impacts of hazards on humans as well as economic and natural resources throughout the state.
4. **Regional Plans**: Multi-Jurisdictional or regional plans are more cost effective methods of developing hazard mitigation plans. With limited mitigation planning staff at the state level, it is important the local plans continue to remain regionalized to the extent possible.
5. **Plan Implementation:** To determine which localities/regions have a higher need for a local hazard mitigation plan can be determined by how much of the plan has been implemented. If localities/regions are actively participating in reducing risk through HMA grants or other funding sources, then they will receive a higher priority than those localities/regions that are not.
6. **Recent Disaster (HMGP Only):** The jurisdiction/region in which a recent disaster declaration has occurred will have a higher priority for receiving funds to revise the hazard mitigation plan that those jurisdictions/regions outside of the impacted area. If the jurisdiction/region impacted already has secured funding for plan revision, then the closest jurisdictions/region outside of the impacted area that have not secured funding will receive highest priority.
7. **Areas with Repetitive Loss and Severe Repetitive Loss:** Areas with higher numbers of repetitive loss and severe repetitive loss properties are an indicator of repetitive damages. These locations will be targeted for mitigation projects through HMA grants to reduce the amount of insurance claims against the NFIP.
8. **Budget and Scope of Work:** The budget and scope of work are an important factor in the national Pre-Disaster Mitigation review. It is important that the state review the budget and scope of work in the same light as VDEM will be managing these grants on the state level.

The Mitigation Administrative Plan outlines the process used to solicit and select HMGP-funded projects. Similar procedures are used for the annual HMA programs, but not within the context of a post-disaster recovery effort.

6.5 Providing Support for Plan Revisions

As well as assisting in providing financial support for local hazard mitigation plan revisions, VDEM mitigation planning staff has been working with each local plan since 2007 to encourage plan implementation and to meet annually to discuss progress of mitigation action items. An interactive Hazard Mitigation Toolkit was developed by VDEM mitigation planning staff and

distributed to each of the local and regional plan sponsors, beginning in 2007. The toolkit includes a combination of FEMA and VDEM planning guidance as well as HMA grant guidance. There are various worksheets, FAQs, and examples to provide the user with a one-stop-shop for local mitigation planning. The toolkit is continually available from VDEM's website: http://www.vaemergency.gov/content/mitigation-toolkit

6.6 Providing technical assistance

Development and update of local hazard mitigation plans and DRU plans is supported by seven all hazard planners of the VDEM Regional Support East and West Divisions of the Department of Emergency Management. This support includes:

- Participation and presentations for local meetings and conferences;
- Availability by phone for consultation, trouble-shooting, and technical assistance;
- Development of draft plan outlines for use at local and regional levels; Compilation of hazard data at the state level where possible for distribution to and use by DRU staff and local plan contacts (for consistency and to kick-start the hazard assessment process, where possible);
- Facilitation of local training workshops for local plan Steering Committees, planning agency staff, and DRU staff;
- Detailed review of draft plan sections and final plan prior to submission to FEMA Region III for final approval;
- Provision of support to local jurisdictions and universities during the plan implementation, monitoring, evaluation, and update process;
- Support of local and regional contacts in developing HMA applications; and
- Providing assistance in improving local risk assessment information and providing GIS support where appropriate.

Information on the revised HIRA from Chapter 3 will be made available to all local plans as they go through the 5-year revision process.

6.7 Local hazard mitigation planning workshops

VDEM Training Education, and Exercise Division hosts an average of two mitigation planning workshops a year across the Commonwealth. The G-393 course is a revision of the G-318

course, which now focuses more on the emergency manager's role in hazard mitigation. Since the 2013 plan, the following trainings have been offered in the Commonwealth:

G393 - Mitigation for Emergency Managers

- October 2013 – Town of Marion (Smyth County)
- May 2014 – City of Newport News
- May 2014 – Prince William County
- December 2015 – Fairfax County
- August 2017 – Henrico County

6.8 Local mitigation planning assistance guides

Several training aides have been distributed to those engaged in local mitigation planning:



The primary training aide has been the *How to Guide* Series developed by FEMA. These have been critical tools vital to plan development, in particular in hazard identification and risk assessment. This series has been distributed widely to those engaged in local planning in printed and digital formats. These documents are also incorporated into the Virginia Hazard Mitigation Toolkit.

6.9 State Review of Local Hazard Mitigation Plans

VDEM mitigation planning staff was involved in the initial development and updates of the local hazard mitigation plans from the grant application through the FEMA final approval. VDEM will not approve or submit a plan to FEMA for review unless it meets all of the FEMA and VDEM local hazard mitigation planning requirements. VDEM regional planners have a 30-day timeline to review local hazard mitigation plans and provide comments, or prepare to submit to FEMA. The PDC submits the plan to VDEM with a request for review and approval, and submittal to FEMA. VDEM provides one electronic copy, one hard copy, and a copy of the plan review tool to FEMA with a letter from the State Coordinator.

VDEM requires that all local hazard mitigation plans include flood maps, and that maps be provided for any hazard receiving a ranking of high. VDEM requires a local capability assessment, and that all local hazard mitigation plans to include a repetitive loss strategy.

6.10 Summary of Loss Avoidance Study

As part of the 2018 update to this plan, VDEM conducted a loss avoidance study on prior mitigation activities. Two communities were chosen for this study – the City of Roanoke and the City of Poquoson. In the City of Roanoke, previously completed private property acquisition projects were studied, to determine the long-term losses avoided by these mitigation activities. In the City of Poquoson, previously completed private property elevation projects were studied, and long-term losses avoided were calculated. These studies required close coordination with the local jurisdictions, as well as input from them on the long-term benefits of these mitigation activities, and were only possible because of the long-term working relationships between these cities and VDEM.

The results of this loss avoidance study can be found in Section 07.

Endnotes

[1] Thomas, Dave. FEMA Region III, personal communication, July 8, 2003
[2] Native American Rights Fund. Pamunkey Tribe of Virginia. Retrieved 07.27.17 from http://www.narf.org/cases/pamunkey-tribe-virginia/

44 CFR, §201.5(b) – Enhanced State Mitigation Plans

Enhanced State Mitigation Plans must include all elements of the Standard State Mitigation Plan identified in §201.4, as well as document the following:

(1) Demonstration that the plan is integrates to the extent practicable with other State and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies.

(2) Documentation of the State's project implementation capability, identifying and demonstrating the ability to implement the plan.

(3) Demonstration that the State effectively uses existing mitigation programs to achieve its mitigation goals.

(4) Demonstration that the State is committed to a comprehensive state mitigation program.

7.1 Compliance with Standard Plan Requirements

The 2018 Commonwealth of Virginia Hazard Mitigation Plan meets all the Standard State Mitigation Plan requirements as set forth in 44 CFR 201.4.

This enhanced pre-disaster planning effort is intended to support state and local governments' efforts to articulate accurate, targeted, and prioritized needs for hazard mitigation that will reduce exposure to natural and human-caused hazards. This planning effort will result in timely allocation of funding and more effective risk reduction strategies and projects.

7.2 Integrated Planning (201.5(b)(1))

A comprehensive hazard mitigation program at the state level must document that it has been integrated into the different arenas of state government planning. The following bullets detail how the state hazard mitigation program has been integrated throughout other state planning processes.

- All 20 multi-jurisdictional hazard mitigation plans in the Commonwealth were integrated into this update including the HIRA, capability assessment, goals, and strategies.
- VDEM staff sit on the Chowan River Basin Technical Advisory Committee, which was set up through the US Army Corps of Engineers to improve the warning capabilities and data collection for flooding events within the river basin. (This river basin was responsible for the severe flooding in the City of Franklin after Hurricane Floyd (VA-DR-1293).)
- VDEM State Hazard Mitigation Officer and Flood Mitigation and Resilience Coordinator serves on the Virginia Silver Jackets Team.
- Localities involved in revising local emergency operation planning are assisted by VDEM planners to integrate the results of the risk assessment in their local hazard mitigation plan into their local EOPs.
- This update will be made available for integration into other state plans as well as local hazard mitigation plan updates. Please see Section 5, actions *MH-12, MH-13, and MH-32* for details.
- Action *MH-15* outlines the need to build support for legislation for integration of local comprehensive plans and local hazard mitigation plans. This action has been modified as local support would be necessary before any legislation could be passed.
- VDEM staff collaborate with state, local, and federal disability partners to form the Access and Functional Needs Advisory Committee. This committee was created to ensure the state had plans to meet the needs individuals with disabilities and access and functional needs during disasters and utilized lessons learned from disasters in other states.
- The scenarios included in the state Threat Hazard Identification and Risk Assessment (THIRA) and Commonwealth THIRA (C-THIRA) are derived from the HIRA in Chapter 3 of this document.

7.3 Project Implementation Capability (201.5(b)(2))

FEMA's Hazard Mitigation Assistance program (HMA) is comprised of three programs that provide funding and assistance to eligible natural hazard mitigation projects and planning efforts: Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), and the post-disaster Hazard Mitigation Grant Program (HMGP). These programs are governed by criteria described in FEMA's *Unified Hazard Mitigation Program*

Guidance, which is published and maintained by FEMA. The guidance described the requirements for feasibility, benefit-cost analysis, and the environmental and historic preservation review process, as well as other eligibility criteria.

Proposed hazard mitigation project applications are submitted to the Commonwealth and FEMA based on the process established in VDEM's Administrative Plan, highlighted below and following.

Pre-Application Procedures
Potential applicants have at least 15 days following the date of the HMA briefing to notify the State Hazard Mitigation Officer (SHMO) of their interest in applying for a grant and designate an individual as the 'Sub-recipient's Authorized Representative' to administer the grant program at the local level. The deadline for notification of interest will be set by the SHMO and published at the briefing. The applicants must submit a completed HMGP pre-application form as notification. The time limitation may be extended by the SHMO when justified and requested in writing by the applicant.

Upon receipt of the above-mentioned forms, the SHMO, in coordination with VDEM Hazard Mitigation Grant Administrators (GAs), will perform eligibility reviews and will notify potential applicants in writing of their eligibility findings.

1. Applicants whose pre-applications were deemed eligible receive a notification of eligibility with instructions on how to apply, with other pertinent application requirements. Applicants whose pre-applications were determined ineligible are offered technical assistance/advice regarding how to achieve program eligibility (if applicable).

Application Procedures
Below are the application procedures VDEM follows for each funding cycle or opportunity:

1. The SHMO has the primary responsibility for ensuring that all applications are properly completed.
2. The date for submission of the application is established by the SHMO. Applicants have at least 60 days following receipt of the SHMO letter stating their eligibility. The SHMO may give extensions upon written request.

3. Upon receipt of a project application, the SHMO and Hazard Mitigation GAs assign a Project Identification Number (PIN) to each application. The PIN consists of the FEMA disaster number, the Federal Identification Processing System (FIPS) Code, and a project number.
4. The SHMO consults with appropriate state agency representatives on the State Hazard Mitigation Advisory Committee to review each application for eligibility in accordance with applicable regulations of the funding program. The SHMO and Hazard Mitigation GAs are responsible for requesting any additional information necessary to make the determination and for notifying applicants of ineligible projects or proposed project status.
5. When several eligible projects compete for limited funding, applications submitted to FEMA will be made in accordance with priorities established in the Mitigation Strategy and by the State Hazard Mitigation Advisory Committee.
6. A stakeholder engagement process was introduced in 2017 for the PDM/FMA and HMGP 4291 grant cycles. Stakeholders helped assign weights to scoring criteria for the established priorities. This was followed by a peer review process, which will continue for future funding cycles.
7. The SHMO is responsible for preparing a complete application, signed by the GAR, which must include a Standard Form (SF) 424, *Application for Federal Assistance*, and SF 424D, *Assurances for Construction Programs* (if appropriate), and a narrative statement to support the package transmitted to FEMA.
8. The application may be amended by VDEM to include measures identified subsequent to the initial application. All supplements identifying new mitigation measures to the application must be made within 90 days of FEMA approval of the Section 322 Mitigation Plan and must contain information as noted in section H.1 of the Administrative Plan.
9. The SHMO and GAs will establish contact with all Sub-recipient's Authorized Representatives and provide technical assistance and project management overview to the Sub-recipients for the duration of the project. Technical expertise and guidance can be obtained through the SHMO, State Hazard Mitigation Committee, and Hazard Mitigation GAs.
10. Time limitations on applications may be extended by the FEMA Regional Administrator when justified and requested in writing by the GAR.
11. The SHMO will notify the applicants and other appropriate parties of funding requests.

Eligibility Determination Criteria for Multi-Hazard Mitigation Measures (201.5(b)(2)(i))
The SHMO and GAs will determine eligibility of the applicant and that minimum program requirements are met by ensuring that each application contains:

1. A reference to the specific section of the State Hazard Mitigation Plan to which the proposed project relates.
2. A narrative describing how the project benefits the designated disaster area (HMGP Only), or how the project reduces risk to future hazards.
3. A completed environmental and historic review as required by FEMA (per 44 CFR, 206.437 (b) (4)(iv)), using guidelines and input established by FEMA, EPA, Virginia Department of Historical Resources, Virginia Department of Environmental Quality, and/or other agencies as is appropriate, and in all cases of mitigation of structures in excess of 50 years of age.
4. NFIP participation requirement and compliance with Executive Order 11988, *Floodplain Management,* and Executive Order 11990, *Protection of Wetlands*.
5. Information sufficient to determine the extent to which the project will solve the problem it is intended to address and the status of any associated dependent or supporting projects.
6. Applicant should document compliance with all applicable federal, state and local codes, including:
    i. A brief history of previous occurrences of the problem the project addresses, including dates and impact of each occurrence or an analysis of projected potential damages if the hazard is not addressed.
    ii. Documentation comparing the proposed project and a listing of influencing factors.
    iii. An estimate of the effective life of the project and a listing of influencing factors.
    iv. An analysis of any pertinent demographic and physical changes to the area or facility to be protected by the project and description of any future maintenance or modifications the project may involve.
    v. A cost analysis to determine whether the benefits to be gained are at least equal to if not greater than the cost of the project, as well as the following points:
        1. Addresses a problem that has been repetitive or one that poses a significant risk to the community if left unresolved
        2. Will not cost more than the anticipated value of the reduction in both direct damages and subsequent negative impacts to the area if future disasters were to occur.

3. Is the most practical, effective, and environmentally sound alternative after consideration of a range of alternative and has the greatest potential impact on reducing future disaster losses.
4. Contributes to a permanent or long-term solution to the problem it is intended to address.
5. Solves a problem independently, or constitutes a functional portion of the solution where there is assurance that the project, as a whole, will be completed.

Project Selection Criteria (201.5(b)(2)(i))

If it is necessary to select from a range of projects due to funding or other constraints, the SHMO, in consultation with the State Hazard Mitigation Advisory Committee using the State Hazard Mitigation Plan, will evaluate and prioritize all eligible applications. A stakeholder group with representation of all seven VDEM regions will be convened to assign weights to scoring criteria to meet the priorities. For HMGP, this ranking will be in accordance with the mitigation strategy established for the disaster and criteria in 44 CFR Sections 206.434(b) and 206.435(b) and (c) as follows:

1. Measures that best fit within an overall plan for development and/or hazard mitigation in the community, disaster area, or state.
2. Measures that, if not taken, will have a detrimental impact on the applicant, such as potential loss of life, loss of essential services, damage to critical facilities, or economic hardship on the community.
3. Measures that have the greatest potential impact on reducing future disaster losses.
4. Measures that are designed to accomplish multiple objectives, including damage reduction, environmental enhancement, and economic recovery.

The SHMO and State Hazard Mitigation Advisory Committee will take into consideration optimizing the total amount of funding available, including overmatching of federal funds with nonfederal funds, when developing this ranking. The SHMO and State Hazard Mitigation Advisory Committee will also consider the level of interest and demonstrated degree of commitment of each applicant when making final project funding selections.

Benefit Cost Analysis for Hazard Mitigation Projects (201.5(b)(2)(ii))

A project must not cost more than the anticipated value of the reduction in both direct damages and subsequent negative impacts to the area if future disasters were to occur.

FEMA's Benefit-Cost Analysis (BCA) software program is used to determine the cost-effectiveness of proposed mitigation projects for FEMA's mitigation grant programs. A BCA evaluates the future benefits (projected losses avoided) of a project in relation its cost. The BCA evaluation results in a benefit-cost ratio (BCR). If the future benefits are equal to or greater than the project cost, then the BCR is equal to or greater than 1.0 and the proposed project is considered cost effective. If the benefits are less than the cost, then the BCR is less than 1.0, and the proposed project is not considered cost effective. Only projects that demonstrate a BCR of 1.0 or greater are considered for HMA funding.

OMB Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, is the basis for the FEMA BCA. The goal of this Circular is to promote efficient resource allocation through well-informed decision-making by the Federal Government. It provides general guidance for conducting benefit-cost and cost-effectiveness analyses. It also provides specific guidance on the discount rates to be used in evaluating Federal programs whose benefits and costs are distributed over time. The general guidance serves as a checklist of whether an agency has considered and properly dealt with all the elements for sound benefit-cost and cost-effectiveness analyses.[1]

FEMA has developed software, written materials, and training to support the effort and assist with estimating the expected future benefits over the useful life of a retrofit project. In January 2017, FEMA released the Benefit Cost Analysis Toolkit version 5.3.0. This version replaces previous versions of the BCA Toolkit.

Eligible applicants must submit a BCA with the project application. The BCA must be accompanied by supporting documentation and a completed data documentation template. The data needed to complete the BCA will vary with the project type and the module selected, but each BCA requires the following general data points:

- Type of mitigation to be implemented;
- Project cost;
- Maintenance cost; and
- Useful life of the project.

In 2013, FEMA released the Environmental Benefits Policy, allowing the use of environmental benefits in the BCA for acquisition projects. The BCA Toolkit will automatically include environmental benefits if the acquisition project has at least a .75

BCR. The environmental benefit will add .25 to the BCR to meet the 1.0 BCR cost effective requirement.

FEMA also released streamlined BCA guidance for projects that acquire or elevate private property within the special flood hazard area. FEMA's Risk Reduction Division completed an analysis of 11,000 elevation and acquisition projects, and determined that the average benefits for each type of project were $175,000 and $276,000, respectively. FEMA also determined that acquisition or elevation of a structure located in a special flood hazard area (as delineated on the Flood Insurance Rate Map or based on best available data) that costs less than or equal to these amounts can be considered cost-effective with no further analysis required.

The SHMO and Hazard Mitigation GAs are experienced and skilled performing BCAs for hundreds of residential acquisition and demolition, elevations, and mitigation reconstruction projects. In addition, BCAs have been performed for successfully funded projects related to drainage improvement and soil stabilization projects.

Mitigation Program Management Capability (201.5(b)(2)(iii))
All program management is handled by the Virginia Department of Emergency Management. The Commonwealth, as the Recipient, has primary responsibility for management and accountability of funds as indicated in 2 CFR 200 and for ensuring that all program and administrative requirements are met as indicated in 2 CFR 200 and the 44 CFR part206 and the *HMA Unified Guidance* as applicable to HMA projects.

Payments and Performance Period
Payment of funds to the Recipient or Sub-recipient for any HMA grant is through a reimbursement process, with the rare and occasional exception of advance payments (as allowed under 2 CFR 200.3 and per 44 CFR 206.437(b)(4)(vi), when determined to be required and necessary for the project to proceed). All reimbursement requests will be handled in a timely and effective manner in compliance with Virginia Prompt Pay requirement and in accordance to2 CFR 200.305.

The Period of Performance for all Hazard Mitigation Grants is typically no more than three years. VDEM Hazard Mitigation GAs will notify the sub-recipients in writing within 90 days in advance of the period of performance end date. If an extension is required, requests must be received in writing by VDEM within 75 days of project

termination date with reasons for requested time of performance extension and a revised milestone table. The request must include:

1. Federal Project Identification Number;
2. Reason(s) for the delay;
3. Original scheduled completion date;
4. New scheduled completion date, including milestones; and
5. Dates and provisions of any previous extensions.

Requests for extensions will be forwarded to FEMA, along with the GAR's recommendation, at least 60 days prior to the end of the project performance period.

If an additional time extension is required, a request will be forwarded to FEMA along with the GAR's recommendation at least 60 days prior to the end of the extended period of performance period.

Progress Reports
The Sub-recipient will provide VDEM with quarterly reports and a final report on the progress of work set forth in the Scope of Services. The quarterly reports and final report shall contain the following components:

1. A narrative describing in detail the progress of the Sub-recipient in fulfilling the provisions of the Scope of Services;
2. Reimbursement requests (per 206.437(b)(4)) as needed which itemize the expenses incurred by the Sub-recipient, including separate columns for the federal, state and the Sub-recipient's matching contribution to the total cost of services as reflected in the approved project budget; and
3. The schedule of specific project tasks with target completion dates and actual completion dates. The first quarterly report is due to VDEM at the end of the first complete quarter following the award of the grant.

Sub-recipients must submit quarterly reports to VDEM on the following schedule:

- Quarter 1 (October 01-December 31) – no later than January 15th
- Quarter 2 (January 01-March 31) – no later than April15th
- Quarter 3 (April 01-June 30) – no later than July 15th

J Quarter 4 (July 01-September 30) – no later than October 15th

Sub-recipient quarterly reports for all active, approved projects will be used by VDEM to compile the required progress reports for FEMA. This report will be submitted to the FEMA Project Officer no later than the last day of the month (January, April, July and October) immediately following each federal fiscal quarter in compliance with the federal audit requirements described in 2 CFR 200.328.

Scope of Work Changes
The Sub-recipient must notify the GAR of any perceived changes to the original scope of work. The written notification must include:

1. Federal HMGP Project Identification Number;
2. Reason(s) for the change as supported by appropriate justification and any relevant documentation: e.g., photographs, standards, etc.;
3. Estimate of the change in cost and referencing the original budget;
4. Original schedule and completion date; and
5. New projected schedule and completion date.

The GAR will evaluate the proposed change(s) and, if necessary, ask FEMA to perform a technical engineering review. The change request and GAR's recommendation will be submitted to FEMA after evaluation of all available information. If FEMA's engineering expertise is required, the GAR will defer recommendation to that agency.

Cost Overruns
When the actual cost of a project exceeds the estimated project cost approved in the application, the Sub-recipient may request additional funding to cover the cost overrun. This request must be submitted to the GAR in writing, and must provide justification for the increased funding.

Cost overrun request are evaluated by the GAR. Those cost overruns that can be met with available federal funds, or that can be met by offsetting cost under runs on other projects (HMGP only), may require approval of FEMA so long as the full scope of work on all affected projects can still be accomplished. Requests that are not justified will be denied by the GAR.

For justified cost overrun which exceed previous federal obligations and require additional federal funds, the GAR will submit a request with a recommendation to the FEMA Region III Administrator for a determination. The Sub-recipient's request and justification will
accompany the GAR's request. Cost overruns require a new BCA, to demonstrate that the project remains cost-effective at the increased price.

All cost overruns must be recorded on the quarterly report.

Duplication of Benefits
VDEM Mitigation staff will work with both FEMA and Sub-recipients to identify and document any possible duplication of benefits concerns. If any are discovered, care will be taken to ensure that there are no inappropriate reimbursements that will create a situation where funds must be returned. If duplication is discovered after a project is completed, VDEM will work with FEMA to recover those funds.

Appeals
The Recipient may appeal any determination made related to federal assistance. Sub-recipients may file, with the Recipient, an appeal of any determination made related to federal assistance. Appeals file by Sub-recipients must be in writing and supported by sufficient documentation (new and compelling information), providing a justification to allow the GAR to make a validity determination on the first appeal. If the Sub-recipient's appeal is found valid after review by the SHMO and the GAR, the appeal will be processed and forwarded to FEMA for review and determination.

If the SHMO, GAR, or FEMA deny the appeal, the actions outlined above apply to any second appeal filed. The second appeal must include new or expanded information to support the need for a second appeal. The second appeal must be made within 60 days of the decisions being appealed. The decision on the second appeal, whether made by the SHMO, GAR, or FEMA, is final.

Compliance Monitoring
As projects are identified 'complete' either through contact with the Sub-recipient, review of quarterly reports, or site visits, VDEM Mitigation GAs prepare a Local Financial Reconciliation Form to help the Sub-recipient prepare for the state's final site visit. Within this form, the Sub-recipient is asked to verify receipt of funds and

expenditure of non-federal match. Concurrent with sending out the Local Financial Reconciliation Form, VDEM schedules the final site visit with the locality.

The site visit includes a site inspection for mitigation program compliance, a review of financial records, and a review of programmatic records. VDEM staff takes digital pictures of each mitigation project structure during the visit and any other relevant areas that will be benefited by the mitigation project. Documents gathered during the site visit, if not previously submitted to VDEM, include:

1. Digital photographs of mitigated structures, infrastructure, affected area;
2. Signed verification of financial reconciliation between VDEM and the Sub-recipient;
3. Latitude and longitude of the project area;
4. Documents produced as defined within the Scope of Work;
5. National Flood Insurance Program policy verification;
6. Elevation certificate(s);
7. Copies of deeds and restrictions on those deeds; and
8. Other pertinent documents or information.

All acquisition projects will be monitored every three (3) years to ensure the integrity of the 'open space in perpetuity' provisions of 44 CFR, Part 80.19.

7.4 Mitigation Action Assessment (201.5(b)(2)(iv))

As part of 2018 update to the State Hazard Mitigation Plan, VDEM completed a loss avoidance study (LAS) of selected previously completed mitigation projects. The entirety of this study can be found in Appendix L, with the methodology and results outlined below.

Project Methodology

A loss avoidance study (LAS) provides a justification for existing and future mitigation projects and activities. The ability to assess the economic performance of mitigation projects over time is important to encourage future funding and continued support of mitigation projects, activities, and programs. An LAS requires that the projects studied be completed prior to the event(s) analyzed, as losses avoided though the mitigation measure

are determined by comparing the damage that would have been caused by the event, had the projects not be implemented.

This LAS looked at previously completed private property mitigation activities in two areas of the Commonwealth – the Cities of Poquoson and Roanoke – and determined the damages the properties would have sustained had they not been acquired or elevated. As the two areas of study implemented different mitigation measures, the specific methodology used for each area is discussed below.

An array of data points was collected to determine the effectiveness of the mitigation projects completed in both study areas. These data points included:

- Original finished floor elevations (pre-mitigation)
- Post-mitigation finished flood elevations
- Base Flood Elevations
- Square footage of the structures
- Structure type
- Cost of the mitigation measure
- Value of the structure
- Value of the structure's contents
- Depth of flooding in project area (post-mitigation)

For both study areas selected, a review of the mitigated properties was conducted. The review included grant documents provided by VDEM, NFIP claims data for the community, and flood history data from both the community and the National Weather Service. After review of this data, specific properties were identified within each study area. The identified properties were found to have the most complete data sets of all properties reviewed.

Data Collection and Structure Selection

The structures studied in Poquoson were all elevated to a minimum of one foot above the applicable base flood elevation (BFE) at the time the project was completed[1]. The selected properties were all elevated after Hurricane Isabel (2003), and are in areas of the City that continue to experience flooding to the present day. The LAS team used a depth-

[1] As of December 2014, Poquoson's ordinance now requires a minimum of three feet of freeboard.

damage calculation that determined the dollar value of losses avoided, based on the likely depth of inundation the structure would have received prior to mitigation. This calculation was then compared to the project cost to elevate the structure to determine the cost-effectiveness of the mitigation.

The subject structures in the City of Roanoke were all acquired and demolished, with the remaining land being converted to greenspace in perpetuity. Most of the structures (11) were acquired in approximately 1996, with a handful (four) acquired approximately ten years later, in approximately 2005.

In the approximately two decades since the original structures were acquired, the City has undertaken the previously discussed array of other flood mitigation measures – namely, the creation of the greenway, the Peters Creek project, and the Roanoke River project.

Each of these projects were implemented or completed during the same timeframe as the study period of the mitigated structures.

While there has been flooding in the City since these structures were acquired, there has been little flooding in the areas where the subject structures were previously located. This is likely due to a combination of factors – most notably the other mitigation activities in the watersheds – and not due to a natural decrease in flooding, as a review of rainfall data in the City does not indicate a decrease in rainfall during the study period.

Losses Avoided Through Mitigation

The City of Roanoke provided documentation and anecdotal information regarding other flood control and mitigation measures enacted in the City over the previous two decades, as well as a wealth of other local information and insight. City staff confirmed that – while there have been floods in the City since these properties were acquired – no flooding has occurred in the project areas since the properties were acquired. A review of the available, documented flood history of the City confirmed this finding.

As there have been no documented flood events in the study area since the properties were acquired and the land returned to greenspace, actual losses avoided cannot be calculated, as there are no post-mitigation damages in the project area to use in the calculation.

Based on the interviews and documentation, it is assumed that these other mitigation and flood control measures (discussed in the LAS) are a significant reason for the lack of flood occurrences since mitigation, though this cannot be confirmed without a detailed hydrology and hydrological study (H&H), which is outside of the scope of the LAS.

For the City of Poquoson, losses avoided were calculated for both a 2009 storm and a 2011 storm. All individual calculations for each structure and both storm events can be found in the complete LAS in appendix L. The aggregate losses avoided for the City of Poquoson projects are presented in the following table.

Table 1: Aggregate Losses Avoided - City of Poquoson

Property ID	Year Built	Number of Stories	Finished Floor Elevation (pre-mitigation)	Finished Floor Elevation (post-mitigation)	Cost of Mitigation	Structure Value	2009 Losses Avoided (Total)	2011 Losses Avoided (Total)	Aggregate Losses Avoided	Aggregate Benefit-Cost Ratio
7	1949	2	3.6 feet	10 feet	$31,850	$65,900	$32,885	$32,884	$65,768	2.06
31	1939	1	4.0 feet	11 feet	$28,150	$63,000	$45,864	$45,864	$91,728	3.23
12	1957	1	4.1 feet	11 feet	$44,350	$86,000	$62,608	$53,406	$116,014	2.61
18	1949	1	4.4 feet	11 feet	$28,150	$51,300	$31,857	$31,857	$63,715	2.26
10	1949	1	4.5 feet	11 feet	$44,350	$73,300	$45,519	$45,519	$91,039	2.05
6	1948	1	4.8 feet	10 feet	$43,150	$94,300	$58,560	$58,560	$117,121	2.71
4	1958	1	5.0 feet	10 feet	$43,150	$105,800	$65,702	$65,702	$131,404	3.04
2	1949	1	5.3 feet	10 feet	$43,250	$95,900	$47,950	$47,950	$95,900	2.21
9	1965	1	5.5 feet	10 feet	$49,350	$75,900	$37,950	$37,950	$75,900	1.53
11	1965	1	5.9 feet	10 feet	$43, 150	$97,000	$48,500	$48,500	$97,000	2.23
5[2]	1949	2	4.6 feet	11 feet	$43,450	$113,500	$47,444	$47,443	$94,886	2.18
15	1949	2	5.0 feet	10 feet	$39,250	$99,100	$41,424	$41,424	$82,848	2.11
16	1949	2	5.0 feet	11 feet	$43,450	$97,600	$40,797	$40,797	$81,594	1.87
24	1955	1	5.0 feet	10 feet	$38,170	$101,800	$63,218	$63,218	$126,436	3.31
14	1949	2	5.3 feet	10 feet	$58,150	$78,000	$25,818	$25,818	$51,636	088
23	1949	1	5.5 feet	10 feet	$56,050	$106,500	$53,251	$53,250	$106,500	1.90
25	1970	1	5.8 feet	10 feet	$74,950	$185,700	$92,850	$92,850	$185,700	2.47
--	--	--	**4.9 feet (Average)**	**10.35 feet (Average)**	**$752,370 (Total)**	**$1,590,600 (Total)**	**$842,194 (Total)**	**$832,992 (Total)**	**$1,675,186 (Total)**	**2.22 (Aggregate)**

As is clear from the preceding table, the private property elevation projects implemented in the City of Poquoson were cost-beneficial. While not every structure has delivered a positive return on the initial investment to date, the project has resulted in at least $2.22 in avoided losses for every dollar spent on mitigation. This positive return on taxpayer investment demonstrates that VDEM, the City of Poquoson, and the Commonwealth as whole have a sound understanding of where and how to fund and implement effective mitigation projects to prevent or reduce future damages and losses.

The overarching goal of mitigation funding is to fund the implementation of measures that avoid or reduce future losses from natural hazards. By documenting project costs and post-implementation losses avoided, it is possible to measure the effectiveness of mitigation programs. Success stories and Best Practices can validate that mitigation can be successfully accomplished both pre- and post-disaster to reduce the impacts of future disasters. While these efforts do not necessarily quantify losses avoided, they can validate that mitigation measures are successful.

Calculating losses avoided requires both pre- mitigation data and post-mitigation data. These data sets can be analyzed in a process similar to a benefit-cost analysis (BCA). Project closeout assessments can provide information for project successes or failures, and can provide data for further loss avoidance studies. Therefore, maintaining detail cost accounting of mitigation projects during and after implementation is essential. When mitigation project costs can be evaluated after implementation, the overall effectiveness of both the project and the Commonwealth's mitigation program can be evaluated.

In addition to the City of Poquoson, VDEM has conducted loss avoidance studies in Gloucester County, Southampton County, and the City of Franklin. In those studies, in less than 7 years after the mitigation activity there was already a 50% savings from future flood damages.

Like most states, VDEM has limited resources to systematically track potential losses avoided for every mitigation project implemented. VDEM does, however, routinely collect and maintain information and documentation of mitigation success stories and best practices. These documents, which are maintained and published by VDEM through their website, provide information and ideas to communities about how they might can use mitigation funding to better protect their community.

Going forward, VDEM will capitalize on opportunities to collect and record data regarding the real-world effectiveness of successful mitigation projects implemented and the losses avoided. This effort may include such actions as evaluating previous flood loss properties following successful mitigation, to determine what damages were avoided by the implementation of the mitigation measure, and including periodic, post-mitigation reports from communities that successfully implement mitigation measures.

7.5 Effective Use of Available Mitigation Funding (201.5(b)(3))

Funds to implement mitigation projects may come from a variety of sources – federal and state governments, private sector, foundations, insurance, and property owners. The funding is often in the form of grants, but may be loans or in-kind contributions.

Most mitigation funds used in the Commonwealth originate with FEMA's mitigation assistance programs – PDM, FMA, and HMGP. The following table provides an overview of the amount and status of funding provided to the Commonwealth between 2011 and 2016.

The table also notes the amount of funding the local sub-recipient and the Commonwealth contributed to the projects. When funding is available, the Commonwealth – through VDEM – contributes up to 20% of the non-federal portion of the project's cost under the HMGP program, resulting in a local cost share of approximately 5% of the total project cost.

Table 2: FEMA Mitigation Spending in Virginia (2011-2016)

Funding Source	Project Type	Federal Share	State Share	Non-federal Share	Total Spending
HMGP (DR-1874)	Structural elevations, planning, drainage improvements, generators	$4,453,630	$1,142,661	$294,542	$5,890,833
HMGP (DR-1905)	Structural elevations, acquisitions, planning, generators, public outreach	$4,181.07	$1,043,525	$55,142	$1,102,848
HMGP (DR-4024)	Structural elevations, drainage improvements, generators, planning, weather radios, public outreach	$6,187,098	$1,654,922	$412,738	$8,254,758
HMGP (DR-4042)	Structural elevations, acquisition, generators, floodproofing, planning, sirens	$6,335,081	$1,572,560	$416,192	$8,323,833
HMGP (DR-4045)	Structural elevations, flood gauges	$1,562,437	$405,047	$103,552	$2,071,036
HMGP (DR-4072)	Structural elevations, generators, planning	$2,408,177	$642,180	$160,545	$3,210,902
HMGP (DR-4092)	Structural elevations, planning	$1,484,338	$395,823	$98,956	$1,979,117
SRL 2011	Mitigation reconstruction	$110,450	--	$11,045	$121,495

Funding Source	Project Type	Federal Share	State Share	Non-federal Share	Total Spending
SRL 2011	Mitigation reconstruction	$110,450	--	$11,045	$121,495
FMA 2013	Structural elevations	$8,165,818	--	$ 216,962	$8,382,780
PDM 2013	Planning	$ 175,309		$ 58,437	$ 233,746
FMA 2014	Structural elevations	$2,589,052	--	$ 78,340	$ 2,667,392
PDM 2014	Acquisition, planning	$658,818	--	$118,111	$776,929
FMA 2015	Structural elevations, acquisition	$3,092,614		$ 14,121	$ 3,106,735
PDM 2015	Generator, planning	$1,095,679	--	$367,072	$1,462,751
FMA 2016	Structural elevations, acquisition	$ 9,092,918	--	$ 111,218	$9,204,136
PDM 2016	Planning	$490,256	--	$163,418	$653,674
Total (2011-2016):		**$49,596,211**	**$6,856,718**	**$2,849,425**	**$59,302,354**

Virginia Disaster Relief Fund

Established in 1995, the Virginia Disaster Relief Fund (VDRF) provides grants to established private non-profit entities to support organizations active in disaster relief and recovery in their missions to assist residents and communities impacted by disasters. Since 2011, the VDRF has provided more than $2.3 million in grants to eligible organizations; the details can be seen in the table following.

Table 3: VDRF Grants Awarded - 2011-2016

Disaster	Total Awarded	Number of Grants	Average Award
152 - Pulaski Tornado	$242,384.00	18	$13,465.78
153 - Other Area Tornados	$89,940.57	10	$8,994.06
154 - Washington Tornado	$713,760.82	124	$5,756.14
155 - Hurricane Irene	$81,974.00	8	$10,246.75
156 - Earthquake	$61,945.00	6	$10,324.17
157 - Tropical Storm Lee	$702,955.00	105	$6,694.81
158 - Derecho	$9,617.00	1	$9,617
159 - Newport News Floods	$75,212.49	32	$2,350.39
160 - Hurricane Sandy	$229,856.99	57	$4,032.58
163 - SWVA Winter Storms	$160,712.45	18	$8,928.47
All Disasters	**$2,368,358.32**	**379**	**$6,248.97**

As of January 2017, the VDRF had $282,226 in general funds available and no private funds available.

Grants Management Summary

VDEM provides timely and accurate performance and financial reports to FEMA regarding mitigation grants. To meeting their reporting requirements to FEMA, VDEM requires Sub-recipients to submit their individual sub-grant reports to VDEM by the 15th of the month following the close of the quarter. VDEM submits their required report to FEMA by the end of the same month.

7.6 Commitment to a Comprehensive Mitigation Program (201.5(b)(4)(i-vi))

As discussed and detailed earlier in Sections 04 (Capability Assessment), 05 (Mitigation Strategy), and 06 (Local Plan Coordination), the Commonwealth, largely but not only through VDEM, has a demonstrated commitment to achieving its published mitigation goals and to building both capacity and capability throughout the Commonwealth.

Local Challenges
Many local jurisdictions and counties are faced with challenges when it comes to development and project management of HMA grant applications. In general, most challenges start with the amount of time employees can contribute to project development and management of the grants. Many times, employees are responsible for numerous roles on a local level and cannot contribute the additional necessary time, especially when there is unfamiliarity with the process and requirements.

The benefit cost analysis is usually the most challenging part of the application process, and as discussed in Section 4, isn't always as cut and dry as the residential projects. More training and tools to specifically address flood mitigation projects would be useful

Project management of HMA grants can also be difficult to manage, specifically the residential projects. There are open HMA projects for which properties end up dropping out do to the inability to come up with the non-federal and non-state share of the project. As discussed in Chapter 4, there has been a shift in dynamic to try and identify more of a private investment moving forward, which will hopefully help address this issue.

Capacity Building
To build and maintain capacity throughout the Commonwealth, VDEM and other state agencies and entities support an array of activities, including planning, technical assistance, and training. These opportunities are provided to communities, universities, organizations, and (in some cases) residents throughout the Commonwealth.

All jurisdictions in the Commonwealth are part of a local hazard mitigation plan. VDEM provides and encourages communities to apply for funding as it is available. Details of the local plan coordination can be found in Section 06 of this plan.

In addition, VDEM provides or organizes planning and project training throughout the Commonwealth on a regular basis; training is also available online through FEMA to any community resident. VDEM has offered more than 170 classroom training opportunities to more than 8,550 students, without trainings offered at locations throughout the Commonwealth. Online training has provided more than 20 courses to more than 765 students[3]. These valuable training opportunities provide communities, first responders, and other emergency management personnel with opportunities to build their own local capacity, which in turn builds capacity throughout the Commonwealth.

Due to the number of disasters in 2016 and 2017, annual HMA grant workshops were not held. However, VDEM grants staff undertook a stakeholder engagement and peer review process in 2017 which was the focus of the outreach strategy. Annual workshops are being scheduled for April and May of 2018. These workshops are geared towards helping local governments understand the HMA programs and how they can benefit from them. The VDEM website is being updated for the 2018 cycle, and VDEM has re-vamped their application process to move from paper applications to our grants management portal Mitigationva.org. In the past, VDEM has found that many project submissions result from discussions had at the annual workshops. There will be one in each of the 7 regions in 2018. The goal in 2018 is to obtain more complete applications, and the electronic submission will assist greatly with that. In addition to the regional meetings, VDEM will host webinars to walk through the grants portal submission process. VDEM is also opening up the HMA cycle earlier in 2018 to allow for more time for applicants to develop their applications.

According to the Association of State Floodplain Managers, there are 412 Certified Floodplain Managers™ in the Commonwealth of Virginia[4]. Given the serious risk that flooding poses to communities throughout Virginia, having this many trained, qualified, and certified floodplain managers in the Commonwealth is a valuable resource, at both the state and local levels.

7.7 Executive Actions (201.5(b)(4)(i-vi))

The Code of Virginia §44-146.17 allows the Governor to appoint an Emergency Coordinator to carry out all provisions of the Code of Virginia related to emergency preparedness, response, and recovery. The Code of Virginia §11-146.22 specifically authorizes the Governor to consider hazard mitigation measures to prevent or reduce the harmful consequences of disaster. The Governor is expected to make recommendations to

the Virginia General Assembly, local governments, and appropriate public and private entities.

Through VDEM, the Commonwealth has two standing mitigation councils – the Virginia Hazard Mitigation Advisory Committee (VHMAC), and the Virginia Hazard Mitigation Working Group (VHMWG). As discussed in Sections 2 (Planning Process) and 8 (Plan Maintenance and Implementation), these groups are essential to providing direction and information to the mitigation planning process in the Commonwealth, both during and between updates.

Building Codes

Through the Virginia Department of Housing and Community Development (DHCD), Virginia has adopted and publishes the Virginia Uniform Statewide Building Code (USBC). The USBC contains building regulations that must be adhered to when constructing new buildings, structures, or additions to existing structures, and when maintaining or repairing an existing building or renovating or changing the use of a building or structure. The USBC is comprised of four parts:

- Virginia Construction Code
- Virginia Rehabilitation Code
- Virginia Maintenance Code
- Errata to the Virginia Building and Fire Regulations

The Board of Housing and Community Development adopts and amends the USBC. The Board bases the technical requirements of the code on nationally-accepted model codes and standards, and makes as few amendments as possible. Enforcement of the USBC is the responsibility of the local government. The local government may charge fees to defray the costs of enforcement and appeals arising from the application of the code[5].

Floodplain Management Ordinances

The Virginia Department of Conservation and Recreation (DCR) is responsible for floodplain management in Virginia. While community participation in FEMA's National Flood Insurance Program is voluntary, any community that elects to join the program is required to adopt and enforce minimum floodplain management standards. In return, FEMA makes flood insurance available for purchase to residents of those communities. The NFIP provides communities with a model ordinance that communities may use to develop their own ordinance, and DCR provides assistance to communities that process, as well as any strengthening of the ordinance that a community may wish to enact[6].

Critical and Essential Facilities

Every incarnation of the Commonwealth's Hazard Mitigation Plan has identified assets throughout the state that are critical and essential to the Commonwealth for post-disaster response and recovery. Every local hazard mitigation plan identifies critical and essential assets for each community's post-disaster response and recovery efforts. Both the Commonwealth and the local plans identify mitigation goals, actions, and strategies to further protect, strengthen, and/or harden these critical and essential facilities, to ensure the availability of necessary resources following a disaster event.

Integration with Post-Disaster Recovery Operations

Through the management and implementation of the HMGP, the Commonwealth and its communities successfully integrate mitigation into post-disaster recovery operations. Through VDEM's administration and oversight, communities can apply for and receive additional funding to enact mitigation measures during the repair/rebuilding process that follows any disaster. Mitigation measures will be at the forefront of any future disaster, with both public assistance and hazard mitigation grants fully integrated into the Finance and Grants Division.

Endnotes

[1] OMB. Circular A-94, Guidelines and Discount Rates for Benefit Cost Analysis for Federal Programs. Retrieved 07.07.17 from, https://obamawhitehouse.archives.gov/omb/circulars_a094
[2] Properties 5, 15, 16, 24, 14, 23, and 25 were funded using CDBG rather than HMGP funds, though they were originally included in the HMGP project application.
[3] VDEM training records, pulled April 2017.
[4] Association of State Floodplain Managers, List of Certified Floodplain Managers, 2017. Retrieved 10.10.17 from http://floods.org/index.asp?menuID=811&firstlevelmenuID=180&siteID=1#VA
[5] Virginia Department of Housing and Community Development, Virginia Uniform Statewide Building Code (USBC). Retrieved 10.10.17 from http://www.dhcd.virginia.gov/index.php/va-building-codes/building-and-fire-codes/regulations/uniform-statewide-building-code-usbc.html
[6] Virginia Department of Conservation and recreation, Floodplain Management Ordinances. Retrieved 10.10.17 from http://www.dcr.virginia.gov/dam-safety-and-floodplains/fpordnce

Disaster Mitigation Act of 2000

§201.4(c)(5): A Plan Maintenance Process that includes:
(i) An established method and schedule for monitoring, evaluating, and updating the plan.
(ii) A system for monitoring implementation of mitigation measures and project closeouts.
(iii) A system for reviewing progress on achieving goals as well as activities and projects identified in the mitigation Strategies.

§201.5(b) Enhanced State Mitigation Plans must include all elements of the Standard State Mitigation Plan identified in §201.4, as well as document the following:
(1) Demonstration that the plan is integrated to the extent practicable with other State and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies.

§201.5(c) Review and updates.
(1) A State must review and revise its plan to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities, and resubmit it for approval to the appropriate Regional Administrator every 5 years. The Regional review will be completed within 45 days after receipt from the State, whenever possible.
(2) In order for a State to be eligible for the 20 percent HMGP funding, the Enhanced State Mitigation Plan must be approved by FEMA within the 5 years prior to the current major disaster declaration.

8.1 Plan Monitoring Procedures

The *Commonwealth of Virginia Hazard Mitigation Plan* was developed and updated with the understanding that as events occur new policies and procedures are added and subtracted, and that other unforeseen circumstances can cause certain elements of the plan to require reconsideration or revisions. It is important to establish a comprehensive monitoring system to ensure that the plan remains a fluid, living document that is regularly reviewed by the Virginia Department of Emergency Management (VDEM) and the Plan's Advisory Committee and Working Group. This will prevent the plan from becoming an unused document, with no influence or ability to inform decision-making in the Commonwealth.

Since 2010, the Commonwealth has received 12 federal disaster declarations – two emergency declaration, two fire management assistance declarations, and eight major disaster declarations[1]. Because of this activity, many resources have been pulled from the implementation of the plan to focus on response and recovery operations. This includes the implementation of the HMGP and local hazard mitigation plan updates. As a result, many of the activities described in the Mitigation Strategy related to property mitigation (i.e., elevation, floodproofing, acquisition, etc.) have received funding and been undertaken. However, this undertaking meant that a new structure was required to adequately monitor and implement this plan.

This new structure began with the 2013 plan update, where a steering committee and four sub-committee structure was revised to an Advisory Committee and a Working Group, with VDEM providing support. This structure was retained for this update, and proved to be effective and an efficient use of all available resources. With support of VDEM and contract planning staff, the Advisory Committee directed the update and enhancement of this plan, and the Working Group provided technical assistance and input.

For the 2018 update, VDEM determined that the Strategic Planning Branch Chief would be the primary VDEM staff contact for this process, with assistance from the Disaster Programs Grants Manager (also SHMO). Working with the Advisory Committee and the Working Group members, this plan update made the best possible use of the available resources, and ensured the best available, most applicable data was made available during the update process.

Future updates to this plan will likely utilize this same structure, which has worked well for this update and the previous update. As with previous plans, VDEM will provide periodic updates to the members of both the Advisory Committee and the Working Group, to inform them of progress made towards the implementation of this plan.

8.2 Tracking Strategies and Projects

State hazard mitigation plans must be reviewed and updated within five years of FEMA approval. Each agency that provides a mitigation strategy or project for this plan is asked to provide an annual report on the progress of those strategies or projects. This practice was begun with the 2010 plan, and continues with this plan update. VDEM developed an annual report template for use in this reporting, to allow for ease of reporting by other

agencies. This unified format not only allows VDEM to monitor and report on plan implementation, but simplifies the data for integration into the plan updates. The form allows agencies to easily and simply report on the following:

- Overall status
- Changes in priority
- Accomplishments
- Costs and cost-effectiveness
- Funding
- Structures and people protected
- Losses avoided
- Relevancy of mitigation goals

A sample of this form can be found in Appendix D.

This process has worked well, and is continued with this update. VDEM staff are responsible for requesting, assessing, and maintaining this information for the life of this plan update. VDEM staff will compile the information received into an annual report for distribution to and review by the members of the Advisory Committee and the Working Group, so that they may determine and direct any interim revisions to the plan.

8.3 Plan Evaluation and Implementation

As the guardian agency of the Commonwealth's Hazard Mitigation Plan, VDEM is responsible for coordinating updates to the plan at least every five years. FEMA-approval of the plan means that the Commonwealth and all localities are eligible for post-disaster federal disaster funding, including Public Assistance (PA) funding for permanent work (Categories C-G) and the Hazard Mitigation Grant Program, as well as for non-disaster mitigation grant funding through the Hazard Mitigation Assistance Program.

During the plan update process, the Commonwealth is responsible for the following tasks:

1) Identifying and profiling hazards and their risks, including:
    a. Description;

   b. Location;
   c. Previous occurrences; and
   d. Extent (i.e., how bad can it get?).
2) Identifying vulnerabilities to identified hazards, including:
   a. Vulnerable populations;
   b. Vulnerable structures;
   c. State facilities;
   d. Estimates of potential losses; and
   e. Incorporating vulnerabilities from local hazard mitigation plans.
3) Identifying capabilities, including:
   a. Commonwealth programs (funding, regulatory, policies);
   b. Federal programs (funding, regulatory, policies);
   c. Local programs (funding, regulatory, policies);
   d. Non-profit programs (funding, regulatory, policies); and
   e. Private programs (funding, regulatory, policies).
4) Develop/validate goals, objectives, and actions to reduce identified risks, including:
   a. Data to support Hazard Identifications and Risk Assessments;
   b. Policy and planning;
   c. Structural mitigation measures; and
   d. Public education and outreach campaigns.
5) Develop an implementation plan for the next five years;
6) Submit the updated plan to FEMA for review and approval; and
7) Ensure adoption by the Commonwealth.

Both the Advisory Committee and the Working Group are critical in assisting VDEM staff with the update and implementation process. Natural disasters do not stop at political or physical boundaries. It is critical to have the support of key stakeholders, and to have those key stakeholders at the table to make decisions that support mitigation policies, efforts, and activities.

8.3.1 Review of eligible HMA grant applications

The Commonwealth is required to have a process in place to prioritize federal funding to localities. A part of this process is the review of grant applications by the Advisory Committee For disaster grants, this happens during the recovery process, but within the statutory timeline. For non-disaster grants, this happens annually, typically in the autumn.

The input from the Advisory Committee members has historically involved reviewing a presentation on the potential grant applications, and input from the members on how well the mitigation solutions proposed in those applications address the identified risk. Beginning in 2017 with the PDM, FMA, and HMGP 4291 cycles VDEM introduced a stakeholder engagement process. VDEM partnered with Old Dominion University's Modeling and Simulation Center to piggyback off of the work that they did on the state homeland security grants. VMASC was tasked to develop enhance the scoring system using stakeholder involvement, and develop a peer review process for HMA applications. The stakeholder group has the following structure:

- VDEM All Hazards Planner from each region (7)
- Two local emergency managers from each region (14)
- One local representative from a non-emergency management discipline (7)
- One planning district commission representative (7)
- Three state agency representatives from the advisory committee (3)
    - Department of Conservation and Recreation – Flood Grants
    - Department of Forestry – Wildfire Grants
    - Department of Mines, Minerals, and Energy – Earthquake/Landslide Grants

The stakeholder meeting took place on August 22, 2017, and the meeting summary can be found in Appendix M.

8.3.2 Meetings to review mitigation initiatives and opportunities

Bi-annually, the Advisory Committee and the Working Group will meet to discuss initiatives and opportunities for mitigation. These meetings will have pre-identified topics of discussion and agendas that will focus on changes in policy or regulations, recent events, and mitigation activities identified in the plan. Subject matter experts may be called in to present on topics, increasing the knowledge of hazards and programs. Periodically, the overall visions and goals of these groups will be reviewed, as will the membership of them.

The process for gathering post-event information to present to the Advisory Committee and Working Groups is:

- Like the process for administering and writing local hazard mitigation plans, the Planning District Commissions (PDCs) will be utilized as a source of information

for mitigation activities and opportunities. VDEM will develop a questionnaire to identify opportunities for mitigation, related to data improvement, policy and planning, structural projects, outreach and education, and other topics of interest. This information will be collected, reviewed, and compiled by VDEM, and presented to the Advisory Committee and Working Group members prior to the bi-annual meetings, so that the members have time to review and be prepared to discuss as necessary.

- Notification of the date, time, and topic of the meeting will be provided to the members at least six weeks in advance of the meeting.
- Meetings may be held in person, via conference calls, or via web hosting.

8.4 Support Post-Disaster Mitigation Operations

Depending on the nature of the event, some or all of the members of the Advisory Committee and the Working Group may be involved in the recovery process. This provides an excellent opportunity to identify mitigation opportunities within the localities, private entities, and the Commonwealth. This involvement could also provide a forum for discussions on a number of topics, including how best to leverage available funding and how best to implement actions and projects to reduce long-term risk and increase the speed at which impacted areas can recover.

8.5 Project Closeout

Project closeout is the process that finalizes a completed mitigation project that FEMA has funded. Closeouts are conducted based on FEMA Region III closeout procedures. FEMA-funded projects are and will continue to be closed out in accordance with national and regional FEMA guidance, and in accordance with Commonwealth and VDEM financial management procedures.

Projects and activities funded through other federal or Commonwealth grant programs, Commonwealth general funds, or that can be achieved without targeted funding are completed as dictated by the funding source or program with administrative oversight for the project.

8.5.1 Required closeout documents

The following Commonwealth documents are required to be submitted with any closeout request letter sent to FEMA:

- Letter from the Governor's Authorized Representative (GAR) requesting the project be closed out, indicating the project is complete and that no further cost adjustments will be required;
- Project Closeout Financial Tracking Report and final budget;
- Verification of deed restrictions (property acquisition projects only);
- Non-conversion Agreement (property elevation projects only);
- Proof of flood insurance (for elevation and floodproofing projects only);
- Form AW501 (if Repetitive Loss property);
- Pre-and post-mitigation site pictures;
- FEMA Closeout Checklist; and
- Any project-specific supporting documentation.

8.5.2 Project closeout documents maintained

The following documents are required to be maintained by the Commonwealth (recipient) and locality (sub-recipient):

- Description of the completed project, including as built design documents for structural projects;
- Assurances that post-award requirements identified in Environmental Review letters were met (if applicable);
- Itemized accounting of expended funds, including non-federal cost share;
- Verification of expenditures, including receipts and vouchers;
- Duplication of Benefits (DoB) verification (property acquisition projects only);
- Verification of deed restrictions (property acquisition projects only);
- Open space reports (property acquisition projects only);
- Non-conversion agreement (property elevation projects only);
- Post-award correspondence; and
- Additional items identified as necessary.

8.5.3 Project closeout process

The following process is used to closeout projects in the Commonwealth:

- Locality (sub-recipient) requests a final project inspection from the Commonwealth (recipient), to receive final payment;
- Commonwealth performs final inspection and project review in cooperation with FEMA, who may attend final inspection;
- Final budget and scope of work adjustments are made and agreed to;
- Commonwealth submits closeout package to FEMA;
- FEMA reviews closeout package, and requests any additional documentation needed; and
- FEMA sends concurrence letter to the Commonwealth for project costs:
    - Commonwealth and FEMA resolve any discrepancies in final project costs;
    - Date of signed concurrence memo is used as the project completion date;
    - FEMA notifies Commonwealth that the project is complete and no additional reports or documents are required; and
    - Commonwealth notifies sub-recipient that the project is closed.

8.6 Plan Amendments

If a specific plan element or section requires revision prior to the next scheduled update of this plan (such as due to a change in Commonwealth or federal legislation or policy), VDEM staff will meet with appropriate stakeholders and propose the change or amendment to FEMA as quickly as practicable.

8.7 Timeline for Next Five Year Update

The following timeline is intended to accomplish the 2023 update to this plan.

Task	Responsible Party	Anticipated Completion
Final Approval from FEMA	VDEM/FEMA	March 15, 2018
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Spring 2018
Request Status of Mitigation Actions from Agencies	VDEM/Agencies	Summer 2018
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Fall 2018

Task	Responsible Party	Anticipated Completion
Annual HMA Prioritization Process	VDEM/AC/WG	Fall 2018
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Spring 2019
Request Status of Mitigation Actions from Agencies	VDEM/Agencies	Summer 2019
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Fall 2019
Annual HMA Prioritization Process	VDEM/AC/WG	Fall 2019
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Spring 2020
Request for Open Space Reporting	VDEM/localities	Summer 2020
Request Status of Mitigation Actions from Agencies	VDEM/Agencies	Summer 2020
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Fall 2020
Annual HMA Prioritization Process	VDEM/AC/WG	Fall 2020
Secure Funding for 2023 Update	VDEM	Fall 2020
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Spring 2021
Request Status of Mitigation Actions from Agencies	VDEM/Agencies	Summer 2021
Begin 2023 Plan Update	VDEM/AC/WG	Summer 2021
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Fall 2021
Annual HMA Prioritization Process	VDEM/AC/WG	Fall 2021
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Spring 2022
Request Status of Mitigation Actions from Agencies	VDEM/Agencies	Summer 2022
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Fall 2022
Annual HMA Prioritization Process	VDEM/AC/WG	Fall 2022
Finalize 2023 Plan Update	VDEM/AC/WG	Fall 2022
Submit 2023 Plan Update to FEMA	VDEM/WG/AC	Winter 2022
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Spring 2023
FEMA Final Approval	VDEM/FEMA	March 15, 2023
Request Status of Mitigation	VDEM/Agencies	Summer 2023

Task	Responsible Party	Anticipated Completion
Actions from Agencies		
Request for Open Space Reporting	VDEM/localities	Summer 2023
Advisory Committee/Working Group Bi-Annual Meeting	VDEM/AC/WG	Fall 2023
Annual HMA Prioritization Process	VDEM/AC/WG	Fall 2023

Endnotes

[1] FEMA. Disaster Declarations Database. Retrieved 08.22.17 from https://www.fema.gov/disasters?field_dv2_state_territory_tribal_value_selective=VA&field_dv2_incident_type_tid=All&field_dv2_declaration_type_value=All&field_dv2_incident_begin_value%5Bvalue%5D%5Bmonth%5D=1&field_dv2_incident_begin_value%5Bvalue%5D%5Byear%5D=2010&field_dv2_incident_end_value%5Bvalue%5D%5Bmonth%5D=12&field_dv2_incident_end_value%5Bvalue%5D%5Byear%5D=2016

Appendix A:

Acronyms

Acronyms

A

ACOE	U.S. Army Corps of Engineers
AICP	American Institute of Certified Planners
APA	American Planning Association
ARC	American Red Cross
ASCE	American Society of Civil Engineers

B

BCA	Benefit-cost analysis
BOCA	Building Officials and Code Administrators
BFE	Base Flood Elevation
BLM	Bureau of Land Management

C

CEM	Comprehensive Emergency Management
CERT	Community Team
CFR	Code of Federal Regulations
CFM	Certified Floodplain Manger
CGIT	Center for Geospatial Information Technology
COV	Code of Virginia
COVEOP	Commonwealth of Virginia Emergency Operations Plan
CPI	Consumer Price Index
CRS	Community Rating System

D

DBHD	Department of Behavioral Health and Development
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
DFIRM	Digital Flood Insurance Rate Map
DGS	Virginia Department of General Services
DHCD	Virginia Department of Housing and Community Development
DHS	Department of Homeland Security
DMA2K	Disaster Mitigation Act of 2000
DMME	Virginia Department of Mines, Minerals, and Energy
DOF	Virginia Department of
DOH	Virginia Department of Health
DOQQ	Digital Orthophoto Quarter Quadrangle
DOS	Department of State

E

EDA	U.S. Economic Development Agency
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EPA	U.S. Environmental Protection Agency
EPM	Emergency Program Manager
ESRI	Environmental Systems Institute

F

FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Agency
FIMA	Flood Insurance Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FMAP	Flood Mitigation Assistance Program
FPI	Fire Potential Index
FPMS	Flood Plan Management
fps	feet per second

G

GIS	Geographic information system
GPS	Global positioning system
GSA	General Services

H

HAZMAT	Hazardous material
HAZUS	Hazards U.S.
HAZUS-MH	Hazards U.S. – Multi-Hazard
HIRA	Hazard Identification and Risk Assessment
HMA	Hazard Mitigation Assistance
HMP	Hazard mitigation plan
HMGP	Hazard Mitigation Grant
HUD	U.S. Department of Housing Urban Development

I

IA	Individual Assistance
IEMS	Integrated Emergency Management System
IFLOWS	Integrated Flood Observing and Warning System

L

LCCC	Local Citizen Corps Committees
LEPC	Local Emergency Planning Committee
LOMA	Letter of Map Amendment
LOMR	Letter of Map Revision

M

MOA	Memorandum of Agreement
MOU	Memorandum of Understandin
mph	g miles per
mps	meters per second
MSL	Mean sea level

N

NBC	Nuclear, Biological, Chemical
NFIP	National Flood Insurance Program
NHC	National Hurricane Center
NIBS	National Institute of Building Sciences
NID	National Inventory of Dams
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	U.S. Natural Resources Conservation Service
NWS	National Weather Service

P

PA	Public Assistance
PGA	Peak Ground Acceleration
PL	Public Law

R

RACES	Radio Amateur Civil Service

S

SBA	U.S. Small Business Administration
SCC	Virginia State Corporation Commission
SEA	Virginia Shoreline Erosion Advisory Service
SHMO	State Hazard Mitigation Officer
SHPO	State Historic Preservation Officer
SLOSH	Sea, Land, and Overland

U

USBC	Uniform Statewide Building Code
USC	
USDA	U.S. Department of Agriculture
USFS	U.S. Forestry Service
USFW	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey

V

VDEM	Virginia Department of Emergency
VDOT	Virginia Department of Transportation
VGIN	Virginia Geographic Network
VOAD	Volunteer Organizations Active in
VRA	Virginia Resources Authority

W

WMD	Weapons of Mass Destruction

Appendix B:

Glossary

The following terms are used throughout this document, but are not necessarily defined when they occur. Many of the definitions provided below are borrowed primarily from the FEMA How-to guides (numbers 1, 2, and 7) and the American Planning Association publication, *Planning for Post-disaster Recovery and Reconstruction* (FEMA 2002, FEMA 2002a, FEMA 2001, Schwab 1998). However, some also are defined specifically from Commonwealth of Virginia statutes and regulations. Words that are in **Boldface** in the definitions also are defined in this glossary. It is hoped that this glossary will provide a common framework for the understanding and use of these terms in the course of hazard mitigation planning in the Commonwealth of Virginia.

0.2% Flood
Also known as the "500-year flood", this is a flood event having a 0.2 percent chance of being equaled or exceeded in any given year.

1% Flood
Also known as the "100-year flood" or "base flood", this is the flood having a 1 percent chance of being equaled or exceeded in any given year. This is the most common reference point statistically for referring to flood events because it is used for regulatory purposes in the **National Flood Insurance Program (NFIP)**.

100-Year Flood
See **1% Flood**.

500-year Flood
See **0.2% Flood**.

Acceleration
The rate of change of **Velocity** with respect to time.

Accretion
This type of sediment movement occurs when more sediment is deposited along a particular area
(*e.g.*, a stream bank or shoreline) than is lost due to erosion.

Acquisition
The process by which local governments may gain possession of lands and other property in high hazard areas through the use of conservation easements, purchase of development rights, or outright purchase of the property.

Asset
Any human-made or natural feature that has value, including but not limited to people; buildings; infrastructure such as bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks

Asset Inventory
An assessment of community **Assets** that are located in each hazard areas. This assessment

should include information about the asset locations, types, function, value, contents (if applicable), and the population of the jurisdiction that may be affected by each hazard event. An estimation of the effect on the jurisdiction of the loss of or damage to this asset also should be considered.

Average Daily Operating Budget
The average cost to operate a facility for one day (including wages, overhead, inventory, etc.)

Base Flood
See **1% Flood**.

Base Flood Elevation (BFE)
The elevation of the **Base Flood** in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The base flood elevation is used as the standard for the National Flood Insurance Program.

Base Map
A map used as a bottom "layer" for risk assessment and hazard analysis. This map should be **Planimetric** and should be as complete, accurate, and current as possible. Other than distinguishable buildings, roads, rivers, coastlines, place names, and a north arrow, the base map should be as uncluttered as possible.

Bedrock
The solid rock that underlies loose material such as soil, sand, clay, or gravel.

Building
Any structure that is walled and roofed, including a storage tank for gas or liquid, which is principally above ground and permanently affixed to a site. This also includes manufactured homes on a permanent foundation on which the wheels and axles carry no weight.

Channelization
The practice of hardening (and more often than not, straightening) the banks of a river or stream to ensure that its path remains predictable and controlled.

City
According to Title 15.2, Section 102 of the COV, a "City" is any independent incorporated community that became a city as provided by law before noon on the first day of July, nineteen hundred seventy-one, or that has within defined boundaries a population of 5,000 or more and that has become a city as provided by law.

Coastal High Hazard Area
As defined under the NFIP, this is an area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high- velocity wave action from storms or seismic sources.

Coastal Zone

The area along the shore where the ocean meets the land as the surface of the land rises above the ocean. This land/water interface includes barrier islands, estuaries, beaches, coastal wetlands, and land areas having direct drainage to the ocean

Community

As defined for the purposes of the NFIP, a community is any state, area, or political jurisdiction or any Native American tribe, authorized tribal organization, Alaska native village, or authorized native organization that has the authority to adopt and enforce floodplain management ordinances for the area under its jurisdiction. In the Commonwealth of Virginia, the recognized government subdivisions "include authority, county, district, and municipality" (COV §13.1-603). The Constitution of Virginia (Article VII, §1 "Definitions") recognizes **Counties, Cities, Towns, and Regional governments**. See also **Local Government**.

Community Rating System (CRS)

A voluntary system under the NFIP in which communities undertake planning and regulatory activities beyond NFIP minimum requirements tin order to obtain credits that earn premium reductions for flood insurance for their residents and property owners. These activities are delineated in the CRS guidelines but include four general categories: public information; mapping and regulatory activities; flood damage reduction; and flood preparedness. The premium reductions come in a series of 5 percent steps based on points earned under the system.

Comprehensive Emergency Management (CEM)

A framework for planning, organizing, and managing emergency protection efforts. There are four recognized phases in the all-hazards approach – mitigation, preparedness, response, and recovery.

Consequences

The damages (full or partial), injuries, and losses of life, property, environment, and business that can be quantified by some unit of measure, often in economic terms.

Constriction

In a **Floodplain**, regrading or filling within or on the edge of a floodplain that obstructs flood flows, backing up floodwaters onto upstream and adjacent properties. Constrictions also increase the velocity of floodwater downstream of the constriction, and reduce the floodplain's ability to store excess water, sending more water downstream and causing floods to rise to higher levels.

Content Loss

Part of the Loss Estimation process, this value represents the total dollar value loss to the contents of a structure as a result of damage from a hazard event. This value (for each affected structure) is equal to the **Content Value** of the structure multiplied by the percent damage experienced by those contents from the hazard event.

Content Value
As part of an asset inventory, this is an estimate of the costs associated with loss of a building's inventory. This value is usually estimated as a percentage of a facility's **Replacement Value**, depending on the **Occupancy Class** of the facility.

Contour
A line of equal ground elevation on a **Topographic** map.

County
As per Title 15.2 Section 102 of the COV, a "County" is any existing county or such unit herafter created.

Critical Facility
Any facility or building that (1) is essential to maintain emergency response actions, (2) provides lifeline services (*e.g.*, shelters, potable water supplies, health facilities), (3) is essential to maintain public safety (*e.g.*, police and fire stations), (4) may cause devastating financial or safety conditions if shut down for more than one week, (5) houses irreplaceable items, records, equipment, or research, (6) houses a special population that requires particular social services on site not needed by the general public (*e.g.*, prisons, nursing home, and advanced care facilities),
or (7) has a special historic or other character.

Critical Fire Weather
A set of weather conditions, usually a combination of wind and low relative humidity, whose effects on fire behavior make fire control difficult and threaten firefighter safety.

Debris
The scattered contents and structural material of homes, businesses, and other structures broken or destroyed in a hazard event. Debris caused by a wind or water hazard events can cause additional damage to other community assets.

Depth of Flooding
The difference between the **Base Flood Elevation** and the **Lowest Floor Elevation**.

Design Wind Speed
The wind velocity for which structures in a specific **Design Wind Speed Zone** must be constructed to withstand. The American Society of Civil Engineers (ASCE) determines the Design
Wind Speeds and Zones.

Design Wind Speed Zone
A zone throughout which the **Design Wind Speed**, as determined by the ASCE, is consistent. There are four zones in the United States: Zone I (winds up to 130 mph); Zone II (winds up to 160 mph); Zone III (winds up to 200 mph); and Zone IV (winds up to 250 mph).

Digital Flood Insurance Rate Map (DFIRM)
A **Flood Insurance Rate Map** that has been updated and produced in digital format for use in GIS
and internet applications.

Digital Orthophoto Quarter Quadrangle (DOQQ)
A computer-generated image of an aerial photograph in which displacements caused by camera orientation and terrain have been removed. These products combine the image characteristics of a photograph with the geometric qualities of a map and can be used in numerous GIS applications either alone or in combination with other digital data.

Disaster
A dangerous event that causes significant human and economic loss and demands a crisis response beyond the scope of any single agency or service such as the fire department or police.

Disaster Mitigation Act of 2000 (DMA2K)
The DMA2K (PL 106-390), signed into law October 10, 2000, amends Section 409 of the **Stafford**
Act, reinforces the importance of mitigation planning, and emphasizes planning for disasters before they occur. It establishes a pre-disaster mitigation program and provides new requirements for the **Hazard Mitigation Grant Program** (HMGP). A complete copy of this Act is provided in the appendix to this plan.

Displacement Cost
The overall dollar amount it would cost for the function of a facility, business, or service to be relocated to another structure because of a hazard event.

Displacement Cost per Day
Part of the Loss Estimation process, this is the average cost per day for a facility to be relocated to a temporary facility as a result of a hazard event. This value can be estimated by dividing the **Displacement Cost** by the **Displacement Time**.

Displacement Time
The average time (in days) that a building's occupants typically must operate from a temporary location while repairs are made to the original building due to damages resulting from a hazard event.

Duration
The length of time a hazard event last.

Earthflow
A type of **Landslide** generally characterized as a combination of a **Slump** and a **Mudflow**.

Earthquake
A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of earth's tectonic plates. See also **Ground Motion**.

Emergency
As defined in the Stafford Act, "any occasion or instance for which, the determination of the president, federal assistance is needed to supplement state and local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe in any part of the United States."

Emergency Management
Organized analysis, planning, decision-making, and assignment of available resources to mitigate, prepare for, respond to, and recover from the effects of all hazards.

Emergency Response Plan
Also known as an emergency operations plan, this is a document that contains information on the actions that may be taken by a governmental jurisdiction to protect people and property before, during, and after a disaster.

Erosion
The wearing away of the land surface by detachment and movement of soil and rock fragments, during a flood or storm or over a period of years, through the action of wind, water, or other geologic processes.

Erosion Hazard Area
The area anticipated to be lost to shoreline retreat over a given period of time. The projected inland extent of the area is measured by multiplying the average annual long-term recession rate by the number of years required.

Exposure
The number, types, qualities, and monetary values of various types of property or infrastructure and life that may be subject to an undesirable or injurious hazard event.

Extent
The size of an area affected by a hazard or hazard event.

Extratropical Cyclone
Cyclonic storm events like Nor'easters and severe winter low-pressure systems. Both the West and East coasts can experience these non-tropical storms that produce gale-force winds and precipitation in the form of heavy rain or snow. Typically called Nor'easters on the East Coast because of the direction of the storm winds, these storms can last for several days and be very large – 1,000 mile-wide storms are not uncommon.

Fault
A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of fracture.

Fire Hazard Severity
The potential for the occurrence of a **Wildfire** due to a combination of slope, fuel availability and type, and prevalence of **Critical Fire Weather** in an area.

Fire Hazard Severity Table
This table correlates **Critical Fire Weather** prevalence, slope, and fuel classification of an area to
estimate an area's degree of fire hazard.

Fire Potential Index (FPI)
Developed by the USGS and USFS, this index is used to assess and map fire hazard potential over broad areas. Using the geographic information from this index, national policy makers and on-the-ground fire managers have established priorities for prevention activities in the defined area to reduce the risk of managed and wildfire ignition and spread. Prediction of fire hazard shortens the time between fire ignition and initial attack by enabling fire managers to pre-allocate and stage suppression forces to high fire risk areas.

Flash Flood
A flood event occurring with little or no warning where water levels rise at an extremely fast rate.

Flood
A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.

Flood Depth
The height of the flood water surface above the ground surface.

Flood Elevation
The elevation of the water surface above an established datum (*e.g.*, the National Geodetic Vertical Datum of 1929; the North American Vertical Datum of 1988; or Mean Sea Level).

Flood Hazard Area
An area as defined on a **Flood Insurance Rate Map** having the possibility to be inundated by a flood of a given magnitude.

Flood Insurance Rate Map (FIRM)
As defined under the NFIP, this is an official map of a community on which the administrator of the Flood Insurance Administration has delineated both the **Special Flood Hazard Areas** and the risk premium zones applicable to that community.

Flood Insurance Study (FIS)
A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.

Flood Zone
A geographical area shown on a FIRM that reflects the severity or type of flooding in the area.

Floodplain (or flood-prone area)
As defined under the NFIP, any land area susceptible to being inundated by water from any source.

Floodplain Management
As defined under the NFIP, the operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works, and floodplain management regulations.

Floodway
See **Regulatory Floodway**.

Frequency
The measure of how often on average a hazard event of a particular magnitude is expected to occur within a particular time frame. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1 percent chance – its **Probability** – of happening in any given year (*e.g.*, a 1% flood).

Fuel
Combustible plant material, both living and dead, that is capable of burning in a wildland situation. Also, any other flammable material in the built environment that feeds a wildfire.

Fujita Scale of Tornado Intensity
This scale rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 indicates wind speeds less than 72 miles per hour and minimal damage such as broken tree limbs or signs, while an F5 indicates wind speeds in excess of 260 miles per hour and severe damage sustained.

Function Loss
Part of the Loss Estimation process, this value represents the functional dollar value loss of a structure/facility as a result of damage from the hazard event. This value (for each affected structure) is equal to the **Average Daily Operating Budget** of the structure multiplied by the **Functional Downtime** plus the **Displacement Cost per Day** multiplied by the **Displacement Time**.

Function Value
An estimate during an asset inventory that represents the value of a building's use or function that would be lost if it were damaged or closed.

Functional Downtime
The average time (in days) during which a function (business or service) is unable to provide its services due to a hazard event.

Geographic Area Impacted
See **Extent**.

Geographic Information System (GIS)
A computer software application that relates physical features on the earth to a database of attributes (descriptions, characteristics) about those physical features to be used for mapping and analysis.

Ground Failure
Permanent deformation of the soil, including faulting, consolidation, liquefaction, or landslides. Ground failure can cause extensive damage to buildings and lifelines, and development in areas prone to ground failure should be avoided.

Ground Motion
Movement of the ground resulting from earthquake-generated waves in the earth. Ground motion normally includes horizontal and vertical components, although the horizontal movement is more severe and causes the greatest damage. Building codes normally address horizontal motion, as vertical motion usually does not exceed gravity design.

Hazard
Generally, any source of potential danger or adverse condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. Hazards may be divided into two broad categories, depending on the source of the event. See also **Natural Hazards** and **Human-caused Hazards.**

Hazard Event
A specific occurrence of a particular type of hazard.

Hazard Identification
See **Hazard Profile**.

Hazard Mitigation
The proactive, preventive planning process of identifying and performing sustained actions to reduce or eliminate the long-term risks to human life and property from hazards and their effects. Note that this emphasis on long-term risk distinguishes mitigation from actions geared primarily to emergency preparedness and short-term recovery.

Hazard Mitigation Grant Program (HMGP)
A grant program authorized under Section 404 of the **Stafford Act**, 42 USC 5170c and implemented at 44 CFR Part 206, Subpart N, that authorizes funding for certain mitigation measures identified through the evaluation of natural hazards conducted under Section 322 of the Stafford Act 42 USC 5165.

Hazard Profile
The process by which the hazards that affect a particular locality or region are identified, described, and defined, including the physical characteristics, magnitude and severity, probability and frequency, causative factors, and extent.

HAZUS

"Hazards U.S." This is a standardized, nationally applicable hazard loss estimation methodology that uses PC-based GIS software. Although originally designed to be used to estimate
earthquake losses, recent updates to the software now include both flood and wind event modules (now known as HAZUS-MH or HAZUS-Multi-hazard). See the FEMA website at http://www.fema.gov/hazus/ for more information and a free download.

Human-caused Hazards

Hazard events that originate from human activity. These types of events may be further defined as either technological hazards or terrorism. **Technological hazards** refer to incidents that may arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials. For the purposes of this sub-definition, it is assumed that technological emergencies are accidental and that their consequences are unintended. **Terrorism** refers to intentional, criminal, malicious acts, specifically those related to the use of weapons of mass destruction (WMD) (including biological, chemical, nuclear, and radiological weapons); arson, incendiary, explosive, and armed attacks; industrial sabotage and intentional hazardous materials releases; and "cyber-terrorism".

Hurricane

An intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 miles per hour or more and blow in a large spiral around a relatively calm center or "eye." Hurricanes develop over the North Atlantic Ocean, northeast Pacific Ocean, or the South Pacific Ocean east of 160° East longitude. Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

Hydrology

The study of water and its properties. A flood discharge model is developed by a hydrologic study.

Infrastructure

Refers to the public services of a community that have a direct impact on the quality of life in that community. These services include communication technology, lifeline systems, and transportation systems. See also **Lifeline Systems**.

Inland Flooding

Flooding that occurs landward of a shoreline as a result of a coastal storm moving across the land bringing torrential rains and backwater flooding from the ocean. These in turn cause rivers and streams in these inland areas to overflow. Severe coastal storms have been known to cause floods in inland areas whose **flood depths** may exceed that expected from a **0.2% flood**.

Integrated Emergency Management System (IEMS)

The application of the **Comprehensive Emergency Management** concept. This program integrates or incorporates all available resources for the full range of hazards and

the full range of functions related to the four phases of emergency management (mitigation, preparedness, response, recovery).

Intensity
A measure of the strength of a hazard event at a particular place.

Inundate / Inundation
To cover or be covered by water, especially from a flood as a result of a severe rainstorm, hurricane, or tsunami.

Landslide
Downward movement of a slope and materials under the force of gravity. There are at least four types of landslides, depending on the content and flow characteristics: **Mudslides**; **Rock Slides**; **Slumps**; and **Earthflows**.

Landslide Hazard Map
These maps show the real extent of a landslide threat, combining data about locations where landslides have occurred in the past, where they are likely to occur now, and where they could occur in the future. When compiled accurately, these maps may be used to predict the relative degree of hazard in a landslide area.

Landslide Inventory
The process by which areas that appear to have failed due to landslides, including debris flows and cut-and-fill failures, are identified.

Landslide Susceptibility Map
These maps show areas that have the potential for landslides by correlating some of the principal factors that contribute to landslides (*i.e.*, steep slopes, geologic units that lose strength when saturated, poorly drained rock or soil, slope angle, and soil drainage characteristics) with the past distribution of landslides in those areas.

Lateral Spread
A type of **Liquefaction**, this develops on gentle slopes and entails the sidelong (downhill) movement of large masses of soil as the underlying layer liquefies.

Level of Acceptable Risk
The amount or degree of potential exposure to loss or injury from a hazard event that a jurisdiction has agreed to comply with when planning the future development of that jurisdiction.

Lifeline Systems
Public works and utilities, such as electrical power, gas and liquid fuels, telecommunications, transportation, and water and sewer systems.

Liquefaction
The temporary loss of shear strength in a water-saturated, cohesion-less soil deposit, or temporary transformation of unconsolidated materials into a fluid mass. Liquefaction causes two types of ground failure: **Lateral Spreads** and **Loss of Bearing Strength**.

Local Government
As defined by the **Disaster Mitigation Act of 2000**, this is any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity. In Virginia, by definition from Title 15.2 Section 102 of the COV a "Local Government" is any county, city, or town as the context may require. See also **Community**.

Locality
See **Local Government**.

Loss of Bearing Strength
A type of **Liquefaction**, this results when the soil supporting a structure liquefies, potentially
causing the structure to tip and topple.

Lowest Floor Elevation
Under the NFIP, this is the elevation of the lowest floor of the lowest enclosed area of a structure (including a basement). This information is available from an elevation certificate (if the building was constructed after a floodplain management ordinance was in force) or from a recorded subdivision plat, site survey, or building permit.

Magnitude
A measure of the strength of a hazard event. The magnitude (also referred to as "severity") of a given hazard event is usually determined using technical measures specific to the hazard.

Major Disaster
As defined by the Stafford Act, "any natural catastrophe…, or, regardless of cause, any fire, flood, or explosion in any part of the United States, which in the determination of the president causes damage of sufficient severity and magnitude to warrant major disaster assistance under this act to supplement the efforts and available resources of states, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby."

Managing State
A State to which FEMA has delegated the authority to administer and manage the HMGP under the criteria established by FEMA pursuant to 42 USC 5170c(c). FEMA also may delegate authority to tribal governments to administer and manage the HMGP as a Managing State.

Mitigate
To cause something to become less harsh, hostile, or destructive; to make less severe or painful.

Mitigation
See **Hazard Mitigation**.

Mitigation Measures / Mitigation Strategies
Those actions proposed and/or undertaken by a jurisdiction to minimize future vulnerability to one or more hazards.

Mitigation Planning
A systematic evaluation of the nature and extent of vulnerability to the effects of hazards typically present in a jurisdiction. This process also includes a description of **Mitigation Measures**.

Modified Mercalli Scale
A subjective measure of the strength (**Intensity**) of the shaking experienced in an seismic event. This scale represents the local effect or damage caused by an earthquake. Also known as **Modified Mercalli Intensity**. See also **Peak Ground Acceleration** and **Richter Magnitude Scale**.

Mudslide / Mudflow
Also known as debris flows, this type of **Landslide** is characterized by flows of well-mixed mass of rock, earth, and water that behaves like a fluid and moves down slopes with consistency similar to that of newly mixed concrete.

Municipality
As defined in Title 15.2 Section 102 of the COV this term shall be construed to relate only to
Cities and **Towns**.

National Flood Insurance Program (NFIP)
A Federal program created by Congress in 1968 that makes flood insurance available in communities that enact the minimum floodplain management regulations defined in 44 CFR §60.3.

National Weather Service (NWS)
A division of the National Oceanographic and Atmospheric Administration (NOAA), the NWS prepares and issues flood, severe weather, and coastal storm warnings and can provide technical assistance to Federal and state entities in preparing weather and flood warning plans.

Natural Hazards
Those events caused by one or more natural occurrences, including hurricanes, tornados, storms, floods, tidal waves, tsunamis, high or wind-driven waters, volcanic eruptions, earthquakes, snowstorms, wildfires, droughts, landslides, and mudslides. While the risks presented by natural hazards may be increased or decreased as a result of human activity, they are not inherently human-induced.

Nor'easter
An **Extratropical Cyclone** producing gale-force winds and precipitation in the form of heavy snow

or rain.

Obstruction
In a **Floodplain**, obstructions are bridges, culverts, and other obstacles that can block flood flow and trap debris, causing increased flooding upstream and increased flood velocity downstream.

Occupancy Class
As part of an asset inventory, this is a description of a facility's general use or function. Based on a facility's Occupancy Class, one also may estimate the **Content Value** and **Replacement Value** using tables developed from regional and national averages.

Outflow
In a coastal storm event, this is the flow of flood waters from inundated areas back to the ocean or bay. Outflow can create strong currents, ripping at structures, pounding them with debris, and eroding beaches and coastal structures.

Peak Ground Acceleration (PGA)
A measure of the strength of ground movements in a seismic event. This measures the rate in change of motion relative to the established rate of acceleration due to gravity (g) (9.8 meters/second/second).

Planimetric
Describes a map in which the information on the map is in true geographic relationship (*i.e.*, it is
"to scale") with measurable horizontal distances.

Planning
The act or process of making or carrying out plans; specifically, the establishment of goals, policies, and procedures for a social or economic unit.

Planning Committee/Team
The core group of **stakeholders** who will see the hazard mitigation planning process through by setting the plan schedule, organizing the work teams, monitoring progress, and coordinating the review and adoption of the various sections of the plan. This committee should include representatives from the following groups: neighborhood groups and other non-profit
organizations; state, regional, and local government representatives; businesses and development organizations; elected officials; Federal agency representatives; and academic institutions. See also **Stakeholder**. (Please refer to the FEMA how-to guide, "Getting Started," Chapter 2 for more information on this topic.)

Preparedness
A condition in which a **Community** is making or has made plans and preparations to strengthen the capability of that community to reduce the impact of, respond to, and recover from a disaster.

Probability

A statistical measure of the likelihood that a hazard event will occur.

Q3 Flood Data

Also known as "Digital Quality Level 3" flood data, these data are a digital representation of certain features on the paper **Flood Insurance Rate Maps**. At present, this data is available on CD-ROM from FEMA for 1,200 counties nationwide. This data is similar to the FIRM data, but does not include hydrographic features (streams, rivers, lakes, and shorelines); base flood elevations;
cross-section lines; roads, road names, or address ranges; and locations,
elevations, and descriptions of benchmarks and elevation reference marks.

Reconstruction

The long-term process following a disaster of rebuilding a community's destroyed housing stock, commercial and industrial buildings, public facilities, and other structures.

Recovery

The actions taken by an individual or community after a catastrophic event to restore order and lifelines in a community. These may be started during but extend beyond the emergency period to that point when the vast majority of such services, including electricity, water, communications,
and public transportation have resumed normal operations. **Short-term recovery** does not include the reconstruction of the built environment (although reconstruction may commence during this period) but primarily focuses on restoring public and utility services. **Long-term recovery**
(see **Reconstruction**) is the process of returning the community, to the extent possible, to the conditions that existed prior to the event, preferably while taking advantage of opportunities to mitigate against future disasters.

Recurrence Interval

The time between hazard events of a similar size in a given location. This interval is based on the probability that the given event will be equaled or exceeded in any given year. See also **1% Flood** and **0.2% Flood**.

Regulatory Floodway

As defined under the NFIP, this is the stream channel and that portion of the adjacent floodplain that must remain open to permit passage of the base flood without raising the water surface elevation by more than one foot.

Repetitive Flood Loss (property)

Any property that has had two or more claims greater than $1,000 paid by the NFIP within any 10- year period since 1978.

Replacement Value

As assessed during an asset inventory, this is the current cost of returning a physical asset to its pre-damaged condition. This usually is expressed in terms of cost per square foot and reflects the present-day cost of labor and materials to construct a building of a particular size, type, and

quality. See also **Content Value**.

Resource Inventory
An analysis of the resources a community can call upon in the event of an emergency.

Response
Those actions taken during a hazard event to provide emergency assistance by addressing immediate life and safety needs, minimize further damage to properties, and speed **Recovery** immediately following a disaster.

Revetments
Rock or other hardened materials (*e.g.*, concrete blocks) placed atop riverbanks , along shorelines, and on slopes to reduce erosion, temper wave action, and improve stream flow.

Richter Magnitude Scale
A numerical scale of earthquake magnitude devised by seismologist C.F. Richter in 1935. This is the common scale with which most of the public is familiar. See also **Modified Mercalli Scale** and **Peak Ground Acceleration**.

Riprap
See **Revetments**.

Risk
The estimated probability that damage will occur to life, property, or the environment if a hazard event occurs. Risk often is expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage as the result of a hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of a hazard event.

Risk Assessment
A process or method for evaluating risk associated with a specific hazard and defined in terms of hazard probability and frequency of occurrence, magnitude and severity (**Intensity**), exposure, and consequences. See also **Risk**, **Vulnerability**, **Exposure**, and **Probability**.

Riverine
Of or produced by a river.

Rock Slide
A type of **Landslide** characterized by the sudden and rapid slide of bedrock along planes of weakness.

Saffir/Simpson Scale
A system for evaluating the intensity and magnitude of hurricanes, based on wind speed, storm surge, and central pressure. This scale ranges from the weakest (Category 1) to the most powerful (Category 5).

Scale
On a map, this is the proportion used in determining a dimensional relationship. It is the ratio of the distance between two points on a map and the actual distance between those two points on the earth's surface. For example, a scale of 1:24,000 means that every one inch on the map is equal to 24,000 inches on the earth's surface.

Scarp
A steep slope.

Scour
The removal of soil or fill material by the flow of floodwaters. The term frequently is used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the **Obstruction** of flow increases turbulence.

Seismicity
Describes the likelihood of an area being subject to earthquakes.

Severe Repetitive Loss Property
A residential property that has experienced at least 4 claims (building only) of $5,000 or more against the NFIP or two claims (building only) of the sum of which exceed the market value of the building.

Slump
A type of **Landslide** characterized by the downward and outward movement of rock or unconsolidated material as unit or as series of units. Also called slope failure

Special Flood Hazard Area (SFHA)
As defined under the NFIP, this is land in the floodplain within a community subject to a 1 percent or greater chance of flooding in any given year.

Stafford Act
The Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 100-707), signed into law November 23, 1988, amending the Disaster Relief Act of 1974 (P.L. 93-288). The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Stakeholder
Individuals or groups that will be affected in any way by an action or policy. They include businesses, private or non-profit organizations, and citizens.

State Hazard Mitigation Officer (SHMO)
The representative of state government who is the primary point of contact with FEMA, other state and federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation programs and activities required under the **Stafford Act**

Storm Surge

The rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface. It is usually manifested as water that is pushed toward the shore by the force of the winds swirling around a storm. These large waves of water sweep across the shorelines where a storm makes landfall. The height of the storm surge will be greater the more intense a storm is. Storm surge areas can be mapped by the probability
of storm surge occurrence using Sea, Lake, and Overland Surges from Hurricanes (SLOSH) modeling.

Storm Tide

A combination of a storm surge and the normal tide. For example, a 15-foot storm surge along with the normal 2-foot tide creates a storm tide of 17 feet.

Structure

See **Building**.

Structure Loss

Part of the Loss Estimation process, this value represents the structural dollar value loss as a result of damage from the hazard event. This value (for each affected structure) is equal to the **Replacement Value** of the structure multiplied by the percent damage experienced by the structure.

Substantial Damage

Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage.

Surface Faulting

The differential movement of two sides of a fracture; the location where the ground breaks apart. This is characterized by the length, width, and displacement along the fault zone.

Sustainability

The concept and practice in which decisions and actions made by the present generation do not reduce the options of future generations. These decisions and actions allow the present generation to pass on to the following generations a natural, economic, and social environment that will provide a continuing high quality of life.

Sustainable

Able to be continued or maintained at a particular level or intensity without depleting the supporting resource.

Sustainable Community

In addition to embracing the ideals of sustainability, a sustainable community also considers the following issues when planning for and with its citizens: environmental quality and quality of life; disaster resistance; economic vitality and a fair legacy for future generations; an understanding of and accounting for the impact of its actions and

policies on adjacent jurisdictions as well as the greater surrounding region and beyond; and an emphasis on combining policies, programs, and design solutions that bring about multiple objectives and seek to address and integrate social and environmental concerns.

Technological Hazard
See "Hazard", above.

Tectonic Plate
Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin other plates. It is the friction between plate boundaries that cause seismic activity. See also **Earthquake**.

Topographic
Describes a map that shows natural features and indicate the physical shape of the land using contour lines. These maps also may include human-made features.

Tornado
A violently rotating column of air extending from a thunderstorm to the ground.

Town
As defined by Title 15.2 Section 102 of the COV this is any existing town or an incorporated community within one or more counties that became a town before noon, July 1, 1971, as provided by law or that has within defined boundaries a population of 1,000 or more and that has become a town as provided by law.

Tropical Cyclone
A generic term for a cyclonic, low-pressure system over tropical or sub-tropical waters.

Tropical Depression
A tropical cyclone with maximum sustained winds of less than 39 mph.

Tropical Storm
A tropical cyclone with maximum sustained winds greater than 39 miles per hour and less than 74 miles per hour.

Tsunami
A great sea wave produced by submarine earth movement or volcanic eruption.

Urban Growth Boundary (UGB)
A politically defined boundary that defines the limits of an urban growth area in an attempt to concentrate growth within a designated area, typically an area where urbanization already is prevalent.

Urban Service Boundary (USB)
A politically defined boundary beyond which public utilities will not be extended. This boundary is determined and enacted by a locality in an attempt to temper and manage urban growth in sensitive and vulnerable areas by limiting the extension of city utilities into undeveloped areas.

Urban Wildfire
A fire moving from a wildland environment, consuming vegetation as fuel, to an urban environment where the fuel consists primarily of buildings and other structures.

Urban/Wildland Interface
A developed area occupying the boundary between an urban or settled area and a wildland characterized by vegetation that can serve as fuel for a forest fire.

Velocity
The speed of a moving object, usually measured in miles per hour, kilometers per hour, feet per second, or meters per second.

Vulnerability
The level or degree of exposure of human life and property to damage from natural or human- caused hazards.

Vulnerability Assessment
The analysis and determination of the overall vulnerability of the population and property in a specified area to possible injury and damage that may result from a hazard event of a given intensity. This assessment analyzes the impact of hazard events on both the existing and future population and built environment.

Wave Height
The height of a wave above the mean water surface level of a lake or ocean.

Wave Runup
The distance or height up to which a wave extends on a steep shoreline, as measured relative to a reference level such as the normal height of the sea.

Wildfire
An uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures.

Wildland Fire
A **Wildfire** in an area in which development is essentially nonexistent, except for roads, power lines, railroads, and other similar features.

Zone
A geographical area shown on a **Flood Insurance Rate Map (FIRM)** that reflects the severity or type of flooding in that area. Flood zones may be classified as A, AE, AO, AH, A99, AR, V, VE, B, C, D, or X. The characteristics of these zones are described on the FIRM.

Appendix C:

Disaster Mitigation Act of 2000 (DMA2K)

DISASTER MITIGATION ACT OF 2000

Public Law 106–390
106th Congress

An Act

Oct. 30, 2000
[H.R. 707]

To amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act to authorize a program for predisaster mitigation, to streamline the administration of disaster relief, to control the Federal costs of disaster assistance, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Disaster Mitigation Act of 2000.

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

42 USC 5121 note.

(a) SHORT TITLE.—This Act may be cited as the ''Disaster Mitigation Act of 2000''.

(b) TABLE OF CONTENTS.—The table of contents of this Act is as follows:

Sec. 1. Short title; table of contents.

TITLE I—PREDISASTER HAZARD MITIGATION

Sec. 101. Findings and purpose.
Sec. 102. Predisaster hazard mitigation.
Sec. 103. Interagency task force.
Sec. 104. Mitigation planning; minimum standards for public and private structures.

TITLE II—STREAMLINING AND COST REDUCTION

Sec. 201. Technical amendments.
Sec. 202. Management costs.
Sec. 203. Public notice, comment, and consultation requirements.
Sec. 204. State administration of hazard mitigation grant program.
Sec. 205. Assistance to repair, restore, reconstruct, or replace damaged facilities.
Sec. 206. Federal assistance to individuals and households.
Sec. 207. Community disaster loans.
Sec. 208. Report on State management of small disasters initiative.
Sec. 209. Study regarding cost reduction.

TITLE III—MISCELLANEOUS

Sec. 301. Technical correction of short title.
Sec. 302. Definitions.
Sec. 303. Fire management assistance.
Sec. 304. Disaster grant closeout procedures.
Sec. 305. Public safety officer benefits for certain Federal and State employees.
Sec. 306. Buy American.
Sec. 307. Treatment of certain real property.
Sec. 308. Study of participation by Indian tribes in emergency management.

TITLE I—PREDISASTER HAZARD MITIGATION

42 USC 5133 note.

SEC. 101. FINDINGS AND PURPOSE.

(a) FINDINGS.—Congress finds that—

(1) natural disasters, including earthquakes, tsunamis, tornadoes, hurricanes, flooding, and wildfires, pose great danger to human life and to property throughout the United States;

(2) greater emphasis needs to be placed on—

(A) identifying and assessing the risks to States and local governments (including Indian tribes) from natural disasters;

(B) implementing adequate measures to reduce losses from natural disasters; and

(C) ensuring that the critical services and facilities of communities will continue to function after a natural disaster;

(3) expenditures for postdisaster assistance are increasing without commensurate reductions in the likelihood of future losses from natural disasters;

(4) in the expenditure of Federal funds under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.), high priority should be given to mitigation of hazards at the local level; and

(5) with a unified effort of economic incentives, awareness and education, technical assistance, and demonstrated Federal support, States and local governments (including Indian tribes) will be able to—

(A) form effective community-based partnerships for hazard mitigation purposes;

(B) implement effective hazard mitigation measures that reduce the potential damage from natural disasters;

(C) ensure continued functionality of critical services;

(D) leverage additional non-Federal resources in meeting natural disaster resistance goals; and

(E) make commitments to long-term hazard mitigation efforts to be applied to new and existing structures.

(b) PURPOSE.—The purpose of this title is to establish a national disaster hazard mitigation program—

(1) to reduce the loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters; and

(2) to provide a source of predisaster hazard mitigation funding that will assist States and local governments (including Indian tribes) in implementing effective hazard mitigation measures that are designed to ensure the continued functionality of critical services and facilities after a natural disaster.

SEC. 102. PREDISASTER HAZARD MITIGATION.

(a) IN GENERAL.—Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5131 et seq.) is amended by adding at the end the following:

''SEC. 203. PREDISASTER HAZARD MITIGATION.

''(a) DEFINITION OF SMALL IMPOVERISHED COMMUNITY.—In this section, the term 'small impoverished community' means a community of 3,000 or fewer individuals that is economically disadvantaged, as determined by the State in which the community is located and based on criteria established by the President.

President.
42 USC 5133.

''(b) ESTABLISHMENT OF PROGRAM.—The President may establish a program to provide technical and financial assistance to States and local governments to assist in the implementation of

predisaster hazard mitigation measures that are cost-effective and are designed to reduce injuries, loss of life, and damage and destruction of property, including damage to critical services and facilities under the jurisdiction of the States or local governments.

''(c) APPROVAL BY PRESIDENT.—If the President determines that a State or local government has identified natural disaster hazards in areas under its jurisdiction and has demonstrated the ability to form effective public-private natural disaster hazard mitigation partnerships, the President, using amounts in the National Predisaster Mitigation Fund established under subsection (i) (referred to in this section as the 'Fund'), may provide technical and financial assistance to the State or local government to be used in accordance with subsection (e).

''(d) STATE RECOMMENDATIONS.—

''(1) IN GENERAL.—

''(A) RECOMMENDATIONS.—The Governor of each State may recommend to the President not fewer than five local governments to receive assistance under this section.

''(B) DEADLINE FOR SUBMISSION.—The recommendations under subparagraph (A) shall be submitted to the President not later than October 1, 2001, and each October 1st thereafter or such later date in the year as the President may establish.

''(C) CRITERIA.—In making recommendations under subparagraph (A), a Governor shall consider the criteria specified in subsection (g).

''(2) USE.—

President. ''(A) IN GENERAL.—Except as provided in subparagraph (B), in providing assistance to local governments under this section, the President shall select from local governments recommended by the Governors under this subsection.

''(B) EXTRAORDINARY CIRCUMSTANCES.—In providing assistance to local governments under this section, the President may select a local government that has not been recommended by a Governor under this subsection if the President determines that extraordinary circumstances justify the selection and that making the selection will further the purpose of this section.

''(3) EFFECT OF FAILURE TO NOMINATE.—If a Governor of a State fails to submit recommendations under this subsection in a timely manner, the President may select, subject to the criteria specified in subsection (g), any local governments of the State to receive assistance under this section.

''(e) USES OF TECHNICAL AND FINANCIAL ASSISTANCE.—

''(1) IN GENERAL.—Technical and financial assistance provided under this section—

''(A) shall be used by States and local governments principally to implement predisaster hazard mitigation measures that are cost-effective and are described in proposals approved by the President under this section; and

''(B) may be used—

''(i) to support effective public-private natural disaster hazard mitigation partnerships;

''(ii) to improve the assessment of a community's vulnerability to natural hazards; or

''(iii) to establish hazard mitigation priorities, and an appropriate hazard mitigation plan, for a community.

''(2) DISSEMINATION.—A State or local government may use not more than 10 percent of the financial assistance received by the State or local government under this section for a fiscal year to fund activities to disseminate information regarding cost-effective mitigation technologies.

''(f) ALLOCATION OF FUNDS.—The amount of financial assistance made available to a State (including amounts made available to local governments of the State) under this section for a fiscal year—

''(1) shall be not less than the lesser of—

''(A) $500,000; or

''(B) the amount that is equal to 1.0 percent of the total funds appropriated to carry out this section for the fiscal year;

''(2) shall not exceed 15 percent of the total funds described in paragraph (1)(B); and

''(3) shall be subject to the criteria specified in subsection (g).

''(g) CRITERIA FOR ASSISTANCE AWARDS.—In determining whether to provide technical and financial assistance to a State or local government under this section, the President shall take into account—

''(1) the extent and nature of the hazards to be mitigated;

''(2) the degree of commitment of the State or local government to reduce damages from future natural disasters;

''(3) the degree of commitment by the State or local government to support ongoing non-Federal support for the hazard mitigation measures to be carried out using the technical and financial assistance;

''(4) the extent to which the hazard mitigation measures to be carried out using the technical and financial assistance contribute to the mitigation goals and priorities established by the State;

''(5) the extent to which the technical and financial assistance is consistent with other assistance provided under this Act;

''(6) the extent to which prioritized, cost-effective mitigation activities that produce meaningful and definable outcomes are clearly identified;

''(7) if the State or local government has submitted a mitigation plan under section 322, the extent to which the activities identified under paragraph (6) are consistent with the mitigation plan;

''(8) the opportunity to fund activities that maximize net benefits to society;

''(9) the extent to which assistance will fund mitigation activities in small impoverished communities; and

''(10) such other criteria as the President establishes in consultation with State and local governments. President.

''(h) FEDERAL SHARE.—

''(1) IN GENERAL.—Financial assistance provided under this section may contribute up to 75 percent of the total cost of mitigation activities approved by the President.

''(2) SMALL IMPOVERISHED COMMUNITIES.—Notwithstanding paragraph (1), the President may contribute up to 90 percent of the total cost of a mitigation activity carried out in a small impoverished community.

''(i) NATIONAL PREDISASTER MITIGATION FUND.—

''(1) ESTABLISHMENT.—The President may establish in the Treasury of the United States a fund to be known as the 'National Predisaster Mitigation Fund', to be used in carrying out this section.

''(2) TRANSFERS TO FUND.—There shall be deposited in the Fund—

''(A) amounts appropriated to carry out this section, which shall remain available until expended; and

''(B) sums available from gifts, bequests, or donations of services or property received by the President for the purpose of predisaster hazard mitigation.

''(3) EXPENDITURES FROM FUND.—Upon request by the President, the Secretary of the Treasury shall transfer from the Fund to the President such amounts as the President determines are necessary to provide technical and financial assistance under this section.

''(4) INVESTMENT OF AMOUNTS.—

''(A) IN GENERAL.—The Secretary of the Treasury shall invest such portion of the Fund as is not, in the judgment of the Secretary of the Treasury, required to meet current withdrawals. Investments may be made only in interest-bearing obligations of the United States.

''(B) ACQUISITION OF OBLIGATIONS.—For the purpose of investments under subparagraph (A), obligations may be acquired—

''(i) on original issue at the issue price; or

''(ii) by purchase of outstanding obligations at the market price.

''(C) SALE OF OBLIGATIONS.—Any obligation acquired by the Fund may be sold by the Secretary of the Treasury at the market price.

''(D) CREDITS TO FUND.—The interest on, and the proceeds from the sale or redemption of, any obligations held in the Fund shall be credited to and form a part of the Fund.

''(E) TRANSFERS OF AMOUNTS.—

''(i) IN GENERAL.—The amounts required to be transferred to the Fund under this subsection shall be transferred at least monthly from the general fund of the Treasury to the Fund on the basis of estimates made by the Secretary of the Treasury.

''(ii) ADJUSTMENTS.—Proper adjustment shall be made in amounts subsequently transferred to the extent prior estimates were in excess of or less than the amounts required to be transferred.

''(j) LIMITATION ON TOTAL AMOUNT OF FINANCIAL ASSISTANCE.—The President shall not provide financial assistance under this section in an amount greater than the amount available in the Fund.

''(k) MULTIHAZARD ADVISORY MAPS.—

''(1) DEFINITION OF MULTIHAZARD ADVISORY MAP.—In this subsection, the term 'multihazard advisory map' means a map

on which hazard data concerning each type of natural disaster is identified simultaneously for the purpose of showing areas of hazard overlap.

''(2) DEVELOPMENT OF MAPS.—In consultation with States, local governments, and appropriate Federal agencies, the President shall develop multihazard advisory maps for areas, in not fewer than five States, that are subject to commonly recurring natural hazards (including flooding, hurricanes and severe winds, and seismic events). President.

''(3) USE OF TECHNOLOGY.—In developing multihazard advisory maps under this subsection, the President shall use, to the maximum extent practicable, the most cost-effective and efficient technology available.

''(4) USE OF MAPS.—

''(A) ADVISORY NATURE.—The multihazard advisory maps shall be considered to be advisory and shall not require the development of any new policy by, or impose any new policy on, any government or private entity.

''(B) AVAILABILITY OF MAPS.—The multihazard advisory maps shall be made available to the appropriate State and local governments for the purposes of—

''(i) informing the general public about the risks of natural hazards in the areas described in paragraph (2);

''(ii) supporting the activities described in subsection (e); and

''(iii) other public uses.

''(l) REPORT ON FEDERAL AND STATE ADMINISTRATION.—Not later than 18 months after the date of the enactment of this section, the President, in consultation with State and local governments, shall submit to Congress a report evaluating efforts to implement this section and recommending a process for transferring greater authority and responsibility for administering the assistance program established under this section to capable States. Deadline.

''(m) TERMINATION OF AUTHORITY.—The authority provided by this section terminates December 31, 2003.''.

(b) CONFORMING AMENDMENT.—Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5131 et seq.) is amended by striking the title heading and inserting the following:

''TITLE II—DISASTER PREPAREDNESS AND MITIGATION ASSISTANCE''.

SEC. 103. INTERAGENCY TASK FORCE.

Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5131 et seq.) (as amended by section 102(a)) is amended by adding at the end the following:

''SEC. 204. INTERAGENCY TASK FORCE. 42 USC 5134.

''(a) IN GENERAL.—The President shall establish a Federal interagency task force for the purpose of coordinating the implementation of predisaster hazard mitigation programs administered by the Federal Government.

''(b) CHAIRPERSON.—The Director of the Federal Emergency Management Agency shall serve as the chairperson of the task force.

''(c) MEMBERSHIP.—The membership of the task force shall include representatives of—

''(1) relevant Federal agencies;

''(2) State and local government organizations (including Indian tribes); and

''(3) the American Red Cross.''.

SEC. 104. MITIGATION PLANNING; MINIMUM STANDARDS FOR PUBLIC AND PRIVATE STRUCTURES.

(a) IN GENERAL.—Title III of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5141 et seq.) is amended by adding at the end the following:

''SEC. 322. MITIGATION PLANNING.

42 USC 5165.

''(a) REQUIREMENT OF MITIGATION PLAN.—As a condition of receipt of an increased Federal share for hazard mitigation measures under subsection (e), a State, local, or tribal government shall develop and submit for approval to the President a mitigation plan that outlines processes for identifying the natural hazards, risks, and vulnerabilities of the area under the jurisdiction of the government.

''(b) LOCAL AND TRIBAL PLANS.—Each mitigation plan developed by a local or tribal government shall—

''(1) describe actions to mitigate hazards, risks, and vulnerabilities identified under the plan; and

''(2) establish a strategy to implement those actions.

''(c) STATE PLANS.—The State process of development of a mitigation plan under this section shall—

''(1) identify the natural hazards, risks, and vulnerabilities of areas in the State;

''(2) support development of local mitigation plans;

''(3) provide for technical assistance to local and tribal governments for mitigation planning; and

''(4) identify and prioritize mitigation actions that the State will support, as resources become available.

''(d) FUNDING.—

''(1) IN GENERAL.—Federal contributions under section 404 may be used to fund the development and updating of mitigation plans under this section.

''(2) MAXIMUM FEDERAL CONTRIBUTION.—With respect to any mitigation plan, a State, local, or tribal government may use an amount of Federal contributions under section 404 not to exceed 7 percent of the amount of such contributions available to the government as of a date determined by the government.

''(e) INCREASED FEDERAL SHARE FOR HAZARD MITIGATION MEASURES.—

''(1) IN GENERAL.—If, at the time of the declaration of a major disaster, a State has in effect an approved mitigation plan under this section, the President may increase to 20 percent, with respect to the major disaster, the maximum percentage specified in the last sentence of section 404(a).

President.

''(2) FACTORS FOR CONSIDERATION.—In determining whether to increase the maximum percentage under paragraph (1), the President shall consider whether the State has established—

''(A) eligibility criteria for property acquisition and other types of mitigation measures;

''(B) requirements for cost effectiveness that are related to the eligibility criteria;

''(C) a system of priorities that is related to the eligibility criteria; and

''(D) a process by which an assessment of the effectiveness of a mitigation action may be carried out after the mitigation action is complete.

''SEC. 323. MINIMUM STANDARDS FOR PUBLIC AND PRIVATE STRUCTURES. 42 USC 5165a.

''(a) IN GENERAL.—As a condition of receipt of a disaster loan or grant under this Act—

''(1) the recipient shall carry out any repair or construction to be financed with the loan or grant in accordance with applicable standards of safety, decency, and sanitation and in conformity with applicable codes, specifications, and standards; and

''(2) the President may require safe land use and construction practices, after adequate consultation with appropriate State and local government officials.

''(b) EVIDENCE OF COMPLIANCE.—A recipient of a disaster loan or grant under this Act shall provide such evidence of compliance with this section as the President may require by regulation.''.

(b) LOSSES FROM STRAIGHT LINE WINDS.—The President shall increase the maximum percentage specified in the last sentence of section 404(a) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5170c(a)) from 15 percent to 20 percent with respect to any major disaster that is in the State of Minnesota and for which assistance is being provided as of the date of the enactment of this Act, except that additional assistance provided under this subsection shall not exceed $6,000,000. The mitigation measures assisted under this subsection shall be related to losses in the State of Minnesota from straight line winds. President.

(c) CONFORMING AMENDMENTS.—

(1) Section 404(a) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5170c(a)) is amended—

(A) in the second sentence, by striking ''section 409'' and inserting ''section 322''; and

(B) in the third sentence, by striking ''The total'' and inserting ''Subject to section 322, the total''.

(2) Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5176) is repealed.

TITLE II—STREAMLINING AND COST REDUCTION

SEC. 201. TECHNICAL AMENDMENTS.

Section 311 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5154) is amended in subsections (a)(1), (b), and (c) by striking ''section 803 of the Public Works and Economic Development Act of 1965'' each place it appears

and inserting ''section 209(c)(2) of the Public Works and Economic Development Act of 1965 (42 U.S.C. 3149(c)(2))''.

SEC. 202. MANAGEMENT COSTS.

(a) IN GENERAL.—Title III of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5141 et seq.) (as amended by section 104(a)) is amended by adding at the end the following:

42 USC 5165b.

''SEC. 324. MANAGEMENT COSTS.

''(a) DEFINITION OF MANAGEMENT COST.—In this section, the term 'management cost' includes any indirect cost, any administrative expense, and any other expense not directly chargeable to a specific project under a major disaster, emergency, or disaster preparedness or mitigation activity or measure.

Regulations.

''(b) ESTABLISHMENT OF MANAGEMENT COST RATES.—Notwithstanding any other provision of law (including any administrative rule or guidance), the President shall by regulation establish management cost rates, for grantees and subgrantees, that shall be used to determine contributions under this Act for management costs.

Deadline.

''(c) REVIEW.—The President shall review the management cost rates established under subsection (b) not later than 3 years after the date of establishment of the rates and periodically thereafter.''.

42 USC 5165b note.

(b) APPLICABILITY.—

(1) IN GENERAL.—Subject to paragraph (2), subsections (a) and (b) of section 324 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (as added by subsection (a)) shall apply to major disasters declared under that Act on or after the date of the enactment of this Act.

(2) INTERIM AUTHORITY.—Until the date on which the President establishes the management cost rates under section 324 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (as added by subsection (a)), section 406(f) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5172(f)) (as in effect on the day before the date of the enactment of this Act) shall be used to establish management cost rates.

SEC. 203. PUBLIC NOTICE, COMMENT, AND CONSULTATION REQUIREMENTS.

Title III of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5141 et seq.) (as amended by section 202(a)) is amended by adding at the end the following:

42 USC 5165c.

''SEC. 325. PUBLIC NOTICE, COMMENT, AND CONSULTATION REQUIREMENTS.

''(a) PUBLIC NOTICE AND COMMENT CONCERNING NEW OR MODIFIED POLICIES.—

President.

''(1) IN GENERAL.—The President shall provide for public notice and opportunity for comment before adopting any new or modified policy that—

''(A) governs implementation of the public assistance program administered by the Federal Emergency Management Agency under this Act; and

''(B) could result in a significant reduction of assistance under the program.

''(2) APPLICATION.—Any policy adopted under paragraph (1) shall apply only to a major disaster or emergency declared on or after the date on which the policy is adopted.

''(b) CONSULTATION CONCERNING INTERIM POLICIES.—

''(1) IN GENERAL.—Before adopting any interim policy under the public assistance program to address specific conditions that relate to a major disaster or emergency that has been declared under this Act, the President, to the maximum extent practicable, shall solicit the views and recommendations of grantees and subgrantees with respect to the major disaster or emergency concerning the potential interim policy, if the interim policy is likely—

''(A) to result in a significant reduction of assistance to applicants for the assistance with respect to the major disaster or emergency; or

''(B) to change the terms of a written agreement to which the Federal Government is a party concerning the declaration of the major disaster or emergency.

''(2) NO LEGAL RIGHT OF ACTION.—Nothing in this subsection confers a legal right of action on any party.

''(c) PUBLIC ACCESS.—The President shall promote public access to policies governing the implementation of the public assistance program.''. President.

SEC. 204. STATE ADMINISTRATION OF HAZARD MITIGATION GRANT PROGRAM.

Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5170c) is amended by adding at the end the following:

''(c) PROGRAM ADMINISTRATION BY STATES.—

''(1) IN GENERAL.—A State desiring to administer the hazard mitigation grant program established by this section with respect to hazard mitigation assistance in the State may submit to the President an application for the delegation of the authority to administer the program.

''(2) CRITERIA.—The President, in consultation and coordination with States and local governments, shall establish criteria for the approval of applications submitted under paragraph (1). The criteria shall include, at a minimum—

''(A) the demonstrated ability of the State to manage the grant program under this section;

''(B) there being in effect an approved mitigation plan under section 322; and

''(C) a demonstrated commitment to mitigation activities.

''(3) APPROVAL.—The President shall approve an application submitted under paragraph (1) that meets the criteria established under paragraph (2). President.

''(4) WITHDRAWAL OF APPROVAL.—If, after approving an application of a State submitted under paragraph (1), the President determines that the State is not administering the hazard mitigation grant program established by this section in a manner satisfactory to the President, the President shall withdraw the approval.

''(5) AUDITS.—The President shall provide for periodic audits of the hazard mitigation grant programs administered by States under this subsection.''. President.

SEC. 205. ASSISTANCE TO REPAIR, RESTORE, RECONSTRUCT, OR REPLACE DAMAGED FACILITIES.

(a) CONTRIBUTIONS.—Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5172) is amended by striking subsection (a) and inserting the following:

''(a) CONTRIBUTIONS.—

''(1) IN GENERAL.—The President may make contributions—

''(A) to a State or local government for the repair, restoration, reconstruction, or replacement of a public facility damaged or destroyed by a major disaster and for associated expenses incurred by the government; and

''(B) subject to paragraph (3), to a person that owns or operates a private nonprofit facility damaged or destroyed by a major disaster for the repair, restoration, reconstruction, or replacement of the facility and for associated expenses incurred by the person.

''(2) ASSOCIATED EXPENSES.—For the purposes of this section, associated expenses shall include—

''(A) the costs of mobilizing and employing the National Guard for performance of eligible work;

''(B) the costs of using prison labor to perform eligible work, including wages actually paid, transportation to a worksite, and extraordinary costs of guards, food, and lodging; and

''(C) base and overtime wages for the employees and extra hires of a State, local government, or person described in paragraph (1) that perform eligible work, plus fringe benefits on such wages to the extent that such benefits were being paid before the major disaster.

''(3) CONDITIONS FOR ASSISTANCE TO PRIVATE NONPROFIT FACILITIES.—

''(A) IN GENERAL.—The President may make contributions to a private nonprofit facility under paragraph (1)(B) only if—

''(i) the facility provides critical services (as defined by the President) in the event of a major disaster; or

''(ii) the owner or operator of the facility—

''(I) has applied for a disaster loan under section 7(b) of the Small Business Act (15 U.S.C. 636(b)); and

''(II)(aa) has been determined to be ineligible for such a loan; or

''(bb) has obtained such a loan in the maximum amount for which the Small Business Administration determines the facility is eligible.

''(B) DEFINITION OF CRITICAL SERVICES.—In this paragraph, the term 'critical services' includes power, water (including water provided by an irrigation organization or facility), sewer, wastewater treatment, communications, and emergency medical care.

''(4) NOTIFICATION TO CONGRESS.—Before making any contribution under this section in an amount greater than $20,000,000, the President shall notify—

''(A) the Committee on Environment and Public Works of the Senate;

''(B) the Committee on Transportation and Infrastructure of the House of Representatives;

''(C) the Committee on Appropriations of the Senate; and

''(D) the Committee on Appropriations of the House of Representatives.''.

(b) FEDERAL SHARE.—Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5172) is amended by striking subsection (b) and inserting the following:

''(b) FEDERAL SHARE.—

''(1) MINIMUM FEDERAL SHARE.—Except as provided in paragraph (2), the Federal share of assistance under this section shall be not less than 75 percent of the eligible cost of repair, restoration, reconstruction, or replacement carried out under this section.

''(2) REDUCED FEDERAL SHARE.—The President shall promulgate regulations to reduce the Federal share of assistance under this section to not less than 25 percent in the case of the repair, restoration, reconstruction, or replacement of any eligible public facility or private nonprofit facility following an event associated with a major disaster— President. Regulations.

''(A) that has been damaged, on more than one occasion within the preceding 10-year period, by the same type of event; and

''(B) the owner of which has failed to implement appropriate mitigation measures to address the hazard that caused the damage to the facility.''.

(c) LARGE IN-LIEU CONTRIBUTIONS.—Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5172) is amended by striking subsection (c) and inserting the following:

''(c) LARGE IN-LIEU CONTRIBUTIONS.—

''(1) FOR PUBLIC FACILITIES.—

''(A) IN GENERAL.—In any case in which a State or local government determines that the public welfare would not best be served by repairing, restoring, reconstructing, or replacing any public facility owned or controlled by the State or local government, the State or local government may elect to receive, in lieu of a contribution under subsection (a)(1)(A), a contribution in an amount equal to 75 percent of the Federal share of the Federal estimate of the cost of repairing, restoring, reconstructing, or replacing the facility and of management expenses.

''(B) AREAS WITH UNSTABLE SOIL.—In any case in which a State or local government determines that the public welfare would not best be served by repairing, restoring, reconstructing, or replacing any public facility owned or controlled by the State or local government because soil instability in the disaster area makes repair, restoration, reconstruction, or replacement infeasible, the State or local government may elect to receive, in lieu of a contribution under subsection (a)(1)(A), a contribution in an amount equal to 90 percent of the Federal share of the Federal estimate of the cost of repairing, restoring, reconstructing, or replacing the facility and of management expenses.

''(C) USE OF FUNDS.—Funds contributed to a State or local government under this paragraph may be used—

''(i) to repair, restore, or expand other selected public facilities;

''(ii) to construct new facilities; or

''(iii) to fund hazard mitigation measures that the State or local government determines to be necessary to meet a need for governmental services and functions in the area affected by the major disaster.

''(D) LIMITATIONS.—Funds made available to a State or local government under this paragraph may not be used for—

''(i) any public facility located in a regulatory floodway (as defined in section 59.1 of title 44, Code of Federal Regulations (or a successor regulation)); or

''(ii) any uninsured public facility located in a special flood hazard area identified by the Director of the Federal Emergency Management Agency under the National Flood Insurance Act of 1968 (42 U.S.C. 4001 et seq.).

''(2) FOR PRIVATE NONPROFIT FACILITIES.—

''(A) IN GENERAL.—In any case in which a person that owns or operates a private nonprofit facility determines that the public welfare would not best be served by repairing, restoring, reconstructing, or replacing the facility, the person may elect to receive, in lieu of a contribution under subsection (a)(1)(B), a contribution in an amount equal to 75 percent of the Federal share of the Federal estimate of the cost of repairing, restoring, reconstructing, or replacing the facility and of management expenses.

''(B) USE OF FUNDS.—Funds contributed to a person under this paragraph may be used—

''(i) to repair, restore, or expand other selected private nonprofit facilities owned or operated by the person;

''(ii) to construct new private nonprofit facilities to be owned or operated by the person; or

''(iii) to fund hazard mitigation measures that the person determines to be necessary to meet a need for the person's services and functions in the area affected by the major disaster.

''(C) LIMITATIONS.—Funds made available to a person under this paragraph may not be used for—

''(i) any private nonprofit facility located in a regulatory floodway (as defined in section 59.1 of title 44, Code of Federal Regulations (or a successor regulation)); or

''(ii) any uninsured private nonprofit facility located in a special flood hazard area identified by the Director of the Federal Emergency Management Agency under the National Flood Insurance Act of 1968 (42 U.S.C. 4001 et seq.).''.

(d) ELIGIBLE COST.—

(1) IN GENERAL.—Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5172) is amended by striking subsection (e) and inserting the following:

''(e) ELIGIBLE COST.—

''(1) DETERMINATION.—

''(A) IN GENERAL.—For the purposes of this section, the President shall estimate the eligible cost of repairing, restoring, reconstructing, or replacing a public facility or private nonprofit facility—

''(i) on the basis of the design of the facility as the facility existed immediately before the major disaster; and

''(ii) in conformity with codes, specifications, and standards (including floodplain management and hazard mitigation criteria required by the President or under the Coastal Barrier Resources Act (16 U.S.C. 3501 et seq.)) applicable at the time at which the disaster occurred.

''(B) COST ESTIMATION PROCEDURES.—

''(i) IN GENERAL.—Subject to paragraph (2), the President shall use the cost estimation procedures established under paragraph (3) to determine the eligible cost under this subsection.

''(ii) APPLICABILITY.—The procedures specified in this paragraph and paragraph (2) shall apply only to projects the eligible cost of which is equal to or greater than the amount specified in section 422.

''(2) MODIFICATION OF ELIGIBLE COST.—

''(A) ACTUAL COST GREATER THAN CEILING PERCENTAGE OF ESTIMATED COST.—In any case in which the actual cost of repairing, restoring, reconstructing, or replacing a facility under this section is greater than the ceiling percentage established under paragraph (3) of the cost estimated under paragraph (1), the President may determine that the eligible cost includes a portion of the actual cost of the repair, restoration, reconstruction, or replacement that exceeds the cost estimated under paragraph (1).

''(B) ACTUAL COST LESS THAN ESTIMATED COST.—

''(i) GREATER THAN OR EQUAL TO FLOOR PERCENTAGE OF ESTIMATED COST.—In any case in which the actual cost of repairing, restoring, reconstructing, or replacing a facility under this section is less than 100 percent of the cost estimated under paragraph (1), but is greater than or equal to the floor percentage established under paragraph (3) of the cost estimated under paragraph (1), the State or local government or person receiving funds under this section shall use the excess funds to carry out cost-effective activities that reduce the risk of future damage, hardship, or suffering from a major disaster.

''(ii) LESS THAN FLOOR PERCENTAGE OF ESTIMATED COST.—In any case in which the actual cost of repairing, restoring, reconstructing, or replacing a facility under this section is less than the floor percentage established under paragraph (3) of the cost estimated under paragraph (1), the State or local government or person receiving assistance under this section shall reimburse the President in the amount of the difference.

''(C) NO EFFECT ON APPEALS PROCESS.—Nothing in this paragraph affects any right of appeal under section 423.

''(3) EXPERT PANEL.—

''(A) ESTABLISHMENT.—Not later than 18 months after the date of the enactment of this paragraph, the President, acting through the Director of the Federal Emergency Management Agency, shall establish an expert panel, which shall include representatives from the construction industry and State and local government.

''(B) DUTIES.—The expert panel shall develop recommendations concerning—

''(i) procedures for estimating the cost of repairing, restoring, reconstructing, or replacing a facility consistent with industry practices; and

''(ii) the ceiling and floor percentages referred to in paragraph (2).

President. ''(C) REGULATIONS.—Taking into account the recommendations of the expert panel under subparagraph (B), the President shall promulgate regulations that establish—

''(i) cost estimation procedures described in subparagraph (B)(i); and

''(ii) the ceiling and floor percentages referred to in paragraph (2).

Deadline. ''(D) REVIEW BY PRESIDENT.—Not later than 2 years after the date of promulgation of regulations under subparagraph (C) and periodically thereafter, the President shall review the cost estimation procedures and the ceiling and floor percentages established under this paragraph.

Deadline. ''(E) REPORT TO CONGRESS.—Not later than 1 year after the date of promulgation of regulations under subparagraph (C), 3 years after that date, and at the end of each 2-year period thereafter, the expert panel shall submit to Congress a report on the appropriateness of the cost estimation procedures.

''(4) SPECIAL RULE.—In any case in which the facility being repaired, restored, reconstructed, or replaced under this section was under construction on the date of the major disaster, the cost of repairing, restoring, reconstructing, or replacing the facility shall include, for the purposes of this section, only those costs that, under the contract for the construction, are the owner's responsibility and not the contractor's responsibility.''.

42 USC 5172 note. (2) EFFECTIVE DATE.—The amendment made by paragraph (1) takes effect on the date of the enactment of this Act and applies to funds appropriated after the date of the enactment of this Act, except that paragraph (1) of section 406(e) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (as amended by paragraph (1)) takes effect on the date on which the cost estimation procedures established under paragraph (3) of that section take effect.

(e) CONFORMING AMENDMENT.—Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5172) is amended by striking subsection (f).

SEC. 206. FEDERAL ASSISTANCE TO INDIVIDUALS AND HOUSEHOLDS.

(a) IN GENERAL.—Section 408 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5174) is amended to read as follows:

''SEC. 408. FEDERAL ASSISTANCE TO INDIVIDUALS AND HOUSEHOLDS.

''(a) IN GENERAL.—

''(1) PROVISION OF ASSISTANCE.—In accordance with this section, the President, in consultation with the Governor of a State, may provide financial assistance, and, if necessary, direct services, to individuals and households in the State who, as a direct result of a major disaster, have necessary expenses and serious needs in cases in which the individuals and households are unable to meet such expenses or needs through other means.

''(2) RELATIONSHIP TO OTHER ASSISTANCE.—Under paragraph (1), an individual or household shall not be denied assistance under paragraph (1), (3), or (4) of subsection (c) solely on the basis that the individual or household has not applied for or received any loan or other financial assistance from the Small Business Administration or any other Federal agency.

''(b) HOUSING ASSISTANCE.—

''(1) ELIGIBILITY.—The President may provide financial or other assistance under this section to individuals and households to respond to the disaster-related housing needs of individuals and households who are displaced from their predisaster primary residences or whose predisaster primary residences are rendered uninhabitable as a result of damage caused by a major disaster.

''(2) DETERMINATION OF APPROPRIATE TYPES OF ASSISTANCE.—

''(A) IN GENERAL.—The President shall determine appropriate types of housing assistance to be provided under this section to individuals and households described in subsection (a)(1) based on considerations of cost effectiveness, convenience to the individuals and households, and such other factors as the President may consider appropriate. President.

''(B) MULTIPLE TYPES OF ASSISTANCE.—One or more types of housing assistance may be made available under this section, based on the suitability and availability of the types of assistance, to meet the needs of individuals and households in the particular disaster situation.

''(c) TYPES OF HOUSING ASSISTANCE.—

''(1) TEMPORARY HOUSING.—

''(A) FINANCIAL ASSISTANCE.—

''(i) IN GENERAL.—The President may provide financial assistance to individuals or households to rent alternate housing accommodations, existing rental units, manufactured housing, recreational vehicles, or other readily fabricated dwellings.

''(ii) AMOUNT.—The amount of assistance under clause (i) shall be based on the fair market rent for the accommodation provided plus the cost of any transportation, utility hookups, or unit installation not provided directly by the President.

''(B) DIRECT ASSISTANCE.—

''(i) IN GENERAL.—The President may provide temporary housing units, acquired by purchase or lease, directly to individuals or households who, because of a lack of available housing resources, would be unable

to make use of the assistance provided under subparagraph (A).

''(ii) PERIOD OF ASSISTANCE.—The President may not provide direct assistance under clause (i) with respect to a major disaster after the end of the 18-month period beginning on the date of the declaration of the major disaster by the President, except that the President may extend that period if the President determines that due to extraordinary circumstances an extension would be in the public interest.

''(iii) COLLECTION OF RENTAL CHARGES.—After the end of the 18-month period referred to in clause (ii), the President may charge fair market rent for each temporary housing unit provided.

''(2) REPAIRS.—

''(A) IN GENERAL.—The President may provide financial assistance for—

''(i) the repair of owner-occupied private residences, utilities, and residential infrastructure (such as a private access route) damaged by a major disaster to a safe and sanitary living or functioning condition; and

''(ii) eligible hazard mitigation measures that reduce the likelihood of future damage to such residences, utilities, or infrastructure.

''(B) RELATIONSHIP TO OTHER ASSISTANCE.—A recipient of assistance provided under this paragraph shall not be required to show that the assistance can be met through other means, except insurance proceeds.

''(C) MAXIMUM AMOUNT OF ASSISTANCE.—The amount of assistance provided to a household under this paragraph shall not exceed $5,000, as adjusted annually to reflect changes in the Consumer Price Index for All Urban Consumers published by the Department of Labor.

''(3) REPLACEMENT.—

''(A) IN GENERAL.—The President may provide financial assistance for the replacement of owner-occupied private residences damaged by a major disaster.

''(B) MAXIMUM AMOUNT OF ASSISTANCE.—The amount of assistance provided to a household under this paragraph shall not exceed $10,000, as adjusted annually to reflect changes in the Consumer Price Index for All Urban Consumers published by the Department of Labor.

''(C) APPLICABILITY OF FLOOD INSURANCE REQUIREMENT.—With respect to assistance provided under this paragraph, the President may not waive any provision of Federal law requiring the purchase of flood insurance as a condition of the receipt of Federal disaster assistance.

''(4) PERMANENT HOUSING CONSTRUCTION.—The President may provide financial assistance or direct assistance to individuals or households to construct permanent housing in insular areas outside the continental United States and in other remote locations in cases in which—

''(A) no alternative housing resources are available; and

''(B) the types of temporary housing assistance described in paragraph (1) are unavailable, infeasible, or not cost-effective.

''(d) TERMS AND CONDITIONS RELATING TO HOUSING ASSISTANCE.—

''(1) SITES.—

''(A) IN GENERAL.—Any readily fabricated dwelling provided under this section shall, whenever practicable, be located on a site that—

''(i) is complete with utilities; and

''(ii) is provided by the State or local government, by the owner of the site, or by the occupant who was displaced by the major disaster.

''(B) SITES PROVIDED BY THE PRESIDENT.—A readily fabricated dwelling may be located on a site provided by the President if the President determines that such a site would be more economical or accessible.

''(2) DISPOSAL OF UNITS.—

''(A) SALE TO OCCUPANTS.—

''(i) IN GENERAL.—Notwithstanding any other provision of law, a temporary housing unit purchased under this section by the President for the purpose of housing disaster victims may be sold directly to the individual or household who is occupying the unit if the individual or household lacks permanent housing.

''(ii) SALE PRICE.—A sale of a temporary housing unit under clause (i) shall be at a price that is fair and equitable.

''(iii) DEPOSIT OF PROCEEDS.—Notwithstanding any other provision of law, the proceeds of a sale under clause (i) shall be deposited in the appropriate Disaster Relief Fund account.

''(iv) HAZARD AND FLOOD INSURANCE.—A sale of a temporary housing unit under clause (i) shall be made on the condition that the individual or household purchasing the housing unit agrees to obtain and maintain hazard and flood insurance on the housing unit.

''(v) USE OF GSA SERVICES.—The President may use the services of the General Services Administration to accomplish a sale under clause (i).

''(B) OTHER METHODS OF DISPOSAL.—If not disposed of under subparagraph (A), a temporary housing unit purchased under this section by the President for the purpose of housing disaster victims—

''(i) may be sold to any person; or

''(ii) may be sold, transferred, donated, or otherwise made available directly to a State or other governmental entity or to a voluntary organization for the sole purpose of providing temporary housing to disaster victims in major disasters and emergencies if, as a condition of the sale, transfer, or donation, the State, other governmental agency, or voluntary organization agrees—

''(I) to comply with the nondiscrimination provisions of section 308; and

''(II) to obtain and maintain hazard and flood insurance on the housing unit.

''(e) FINANCIAL ASSISTANCE TO ADDRESS OTHER NEEDS.—

''(1) MEDICAL, DENTAL, AND FUNERAL EXPENSES.—The President, in consultation with the Governor of a State, may provide financial assistance under this section to an individual or household in the State who is adversely affected by a major disaster to meet disaster-related medical, dental, and funeral expenses.

''(2) PERSONAL PROPERTY, TRANSPORTATION, AND OTHER EXPENSES.—The President, in consultation with the Governor of a State, may provide financial assistance under this section to an individual or household described in paragraph (1) to address personal property, transportation, and other necessary expenses or serious needs resulting from the major disaster.

''(f) STATE ROLE.—

''(1) FINANCIAL ASSISTANCE TO ADDRESS OTHER NEEDS.—

''(A) GRANT TO STATE.—Subject to subsection (g), a Governor may request a grant from the President to provide financial assistance to individuals and households in the State under subsection (e).

''(B) ADMINISTRATIVE COSTS.—A State that receives a grant under subparagraph (A) may expend not more than 5 percent of the amount of the grant for the administrative costs of providing financial assistance to individuals and households in the State under subsection (e).

''(2) ACCESS TO RECORDS.—In providing assistance to individuals and households under this section, the President shall provide for the substantial and ongoing involvement of the States in which the individuals and households are located, including by providing to the States access to the electronic records of individuals and households receiving assistance under this section in order for the States to make available any additional State and local assistance to the individuals and households.

''(g) COST SHARING.—

''(1) FEDERAL SHARE.—Except as provided in paragraph (2), the Federal share of the costs eligible to be paid using assistance provided under this section shall be 100 percent.

''(2) FINANCIAL ASSISTANCE TO ADDRESS OTHER NEEDS.—In the case of financial assistance provided under subsection (e)—

''(A) the Federal share shall be 75 percent; and

''(B) the non-Federal share shall be paid from funds made available by the State.

''(h) MAXIMUM AMOUNT OF ASSISTANCE.—

''(1) IN GENERAL.—No individual or household shall receive financial assistance greater than $25,000 under this section with respect to a single major disaster.

''(2) ADJUSTMENT OF LIMIT.—The limit established under paragraph (1) shall be adjusted annually to reflect changes in the Consumer Price Index for All Urban Consumers published by the Department of Labor.

President. ''(i) RULES AND REGULATIONS.—The President shall prescribe rules and regulations to carry out this section, including criteria, standards, and procedures for determining eligibility for assistance.''.

(b) CONFORMING AMENDMENT.—Section 502(a)(6) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5192(a)(6)) is amended by striking ''temporary housing''.

(c) ELIMINATION OF INDIVIDUAL AND FAMILY GRANT PROGRAMS.—Section 411 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5178) is repealed.

(d) EFFECTIVE DATE.—The amendments made by this section take effect 18 months after the date of the enactment of this Act. 42 USC 5174 note.

SEC. 207. COMMUNITY DISASTER LOANS.

Section 417 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5184) is amended—

(1) by striking ''(a) The President'' and inserting the following:

''(a) IN GENERAL.—The President'';

(2) by striking ''The amount'' and inserting the following:

''(b) AMOUNT.—The amount'';

(3) by striking ''Repayment'' and inserting the following:

''(c) REPAYMENT.—

''(1) CANCELLATION.—Repayment'';

(4) by striking ''(b) Any loans'' and inserting the following:

''(d) EFFECT ON OTHER ASSISTANCE.—Any loans'';

(5) in subsection (b) (as designated by paragraph (2))—

(A) by striking ''and shall'' and inserting ''shall''; and

(B) by inserting before the period at the end the following: '', and shall not exceed $5,000,000''; and

(6) in subsection (c) (as designated by paragraph (3)), by adding at the end the following:

''(2) CONDITION ON CONTINUING ELIGIBILITY.—A local government shall not be eligible for further assistance under this section during any period in which the local government is in arrears with respect to a required repayment of a loan under this section.''.

SEC. 208. REPORT ON STATE MANAGEMENT OF SMALL DISASTERS INITIATIVE.

42 USC 5121 note.

Not later than 3 years after the date of the enactment of this Act, the President shall submit to Congress a report describing the results of the State Management of Small Disasters Initiative, including— Deadline.

(1) identification of any administrative or financial benefits of the initiative; and

(2) recommendations concerning the conditions, if any, under which States should be allowed the option to administer parts of the assistance program under section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5172).

SEC. 209. STUDY REGARDING COST REDUCTION.

Not later than 3 years after the date of the enactment of this Act, the Director of the Congressional Budget Office shall complete a study estimating the reduction in Federal disaster assistance that has resulted and is likely to result from the enactment of this Act. 42 USC 5121 note. Deadline.

TITLE III—MISCELLANEOUS

SEC. 301. TECHNICAL CORRECTION OF SHORT TITLE.

The first section of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 note) is amended to read as follows:

''SECTION 1. SHORT TITLE.

''This Act may be cited as the 'Robert T. Stafford Disaster Relief and Emergency Assistance Act'.''.

SEC. 302. DEFINITIONS.

Section 102 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5122) is amended—

(1) in each of paragraphs (3) and (4), by striking ''the Northern'' and all that follows through ''Pacific Islands'' and inserting ''and the Commonwealth of the Northern Mariana Islands'';

(2) by striking paragraph (6) and inserting the following:

''(6) LOCAL GOVERNMENT.—The term 'local government' means—

''(A) a county, municipality, city, town, township, local public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government;

''(B) an Indian tribe or authorized tribal organization, or Alaska Native village or organization; and

''(C) a rural community, unincorporated town or village, or other public entity, for which an application for assistance is made by a State or political subdivision of a State.''; and

(3) in paragraph (9), by inserting ''irrigation,'' after ''utility,''.

SEC. 303. FIRE MANAGEMENT ASSISTANCE.

(a) IN GENERAL.—Section 420 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5187) is amended to read as follows:

''SEC. 420. FIRE MANAGEMENT ASSISTANCE.

''(a) IN GENERAL.—The President is authorized to provide assistance, including grants, equipment, supplies, and personnel, to any State or local government for the mitigation, management, and control of any fire on public or private forest land or grassland that threatens such destruction as would constitute a major disaster.

President. ''(b) COORDINATION WITH STATE AND TRIBAL DEPARTMENTS OF FORESTRY.—In providing assistance under this section, the President shall coordinate with State and tribal departments of forestry.

''(c) ESSENTIAL ASSISTANCE.—In providing assistance under this section, the President may use the authority provided under section 403.

''(d) RULES AND REGULATIONS.—The President shall prescribe such rules and regulations as are necessary to carry out this section.''. President.

(b) EFFECTIVE DATE.—The amendment made by subsection (a) takes effect 1 year after the date of the enactment of this Act. 42 USC 5187 note.

SEC. 304. DISASTER GRANT CLOSEOUT PROCEDURES. 42 USC 5205.

Title VII of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5101 et seq.) is amended by adding at the end the following:

''SEC. 705. DISASTER GRANT CLOSEOUT PROCEDURES.

''(a) STATUTE OF LIMITATIONS.—

''(1) IN GENERAL.—Except as provided in paragraph (2), no administrative action to recover any payment made to a State or local government for disaster or emergency assistance under this Act shall be initiated in any forum after the date that is 3 years after the date of transmission of the final expenditure report for the disaster or emergency.

''(2) FRAUD EXCEPTION.—The limitation under paragraph (1) shall apply unless there is evidence of civil or criminal fraud.

''(b) REBUTTAL OF PRESUMPTION OF RECORD MAINTENANCE.—

''(1) IN GENERAL.—In any dispute arising under this section after the date that is 3 years after the date of transmission of the final expenditure report for the disaster or emergency, there shall be a presumption that accounting records were maintained that adequately identify the source and application of funds provided for financially assisted activities.

''(2) AFFIRMATIVE EVIDENCE.—The presumption described in paragraph (1) may be rebutted only on production of affirmative evidence that the State or local government did not maintain documentation described in that paragraph.

''(3) INABILITY TO PRODUCE DOCUMENTATION.—The inability of the Federal, State, or local government to produce source documentation supporting expenditure reports later than 3 years after the date of transmission of the final expenditure report shall not constitute evidence to rebut the presumption described in paragraph (1).

''(4) RIGHT OF ACCESS.—The period during which the Federal, State, or local government has the right to access source documentation shall not be limited to the required 3-year retention period referred to in paragraph (3), but shall last as long as the records are maintained.

''(c) BINDING NATURE OF GRANT REQUIREMENTS.—A State or local government shall not be liable for reimbursement or any other penalty for any payment made under this Act if—

''(1) the payment was authorized by an approved agreement specifying the costs;

''(2) the costs were reasonable; and

''(3) the purpose of the grant was accomplished.''.

SEC. 305. PUBLIC SAFETY OFFICER BENEFITS FOR CERTAIN FEDERAL AND STATE EMPLOYEES.

(a) IN GENERAL.—Section 1204 of the Omnibus Crime Control and Safe Streets Act of 1968 (42 U.S.C. 3796b) is amended by striking paragraph (7) and inserting the following:

''(7) 'public safety officer' means—

''(A) an individual serving a public agency in an official capacity, with or without compensation, as a law enforcement officer, as a firefighter, or as a member of a rescue squad or ambulance crew;

''(B) an employee of the Federal Emergency Management Agency who is performing official duties of the Agency in an area, if those official duties—

''(i) are related to a major disaster or emergency that has been, or is later, declared to exist with respect to the area under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.); and

''(ii) are determined by the Director of the Federal Emergency Management Agency to be hazardous duties; or

''(C) an employee of a State, local, or tribal emergency management or civil defense agency who is performing official duties in cooperation with the Federal Emergency Management Agency in an area, if those official duties—

''(i) are related to a major disaster or emergency that has been, or is later, declared to exist with respect to the area under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.); and

''(ii) are determined by the head of the agency to be hazardous duties.''.

42 USC 3796b note.

(b) EFFECTIVE DATE.—The amendment made by subsection (a) applies only to employees described in subparagraphs (B) and (C) of section 1204(7) of the Omnibus Crime Control and Safe Streets Act of 1968 (as amended by subsection (a)) who are injured or who die in the line of duty on or after the date of the enactment of this Act.

42 USC 5206.

SEC. 306. BUY AMERICAN.

(a) COMPLIANCE WITH BUY AMERICAN ACT.—No funds authorized to be appropriated under this Act or any amendment made by this Act may be expended by an entity unless the entity, in expending the funds, complies with the Buy American Act (41 U.S.C. 10a et seq.).

(b) DEBARMENT OF PERSONS CONVICTED OF FRAUDULENT USE OF ''MADE IN AMERICA'' LABELS.—

Deadline.

(1) IN GENERAL.—If the Director of the Federal Emergency Management Agency determines that a person has been convicted of intentionally affixing a label bearing a ''Made in America'' inscription to any product sold in or shipped to the United States that is not made in America, the Director shall determine, not later than 90 days after determining that the person has been so convicted, whether the person should be debarred from contracting under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.).

(2) DEFINITION OF DEBAR.—In this subsection, the term ''debar'' has the meaning given the term in section 2393(c) of title 10, United States Code.

SEC. 307. TREATMENT OF CERTAIN REAL PROPERTY.

(a) IN GENERAL.—Notwithstanding the National Flood Insurance Act of 1968 (42 U.S.C. 4001 et seq.), the Flood Disaster

Protection Act of 1973 (42 U.S.C. 4002 et seq.), or any other provision of law, or any flood risk zone identified, delineated, or established under any such law (by flood insurance rate map or otherwise), the real property described in subsection (b) shall not be considered to be, or to have been, located in any area having special flood hazards (including any floodway or floodplain).

(b) REAL PROPERTY.—The real property described in this subsection is all land and improvements on the land located in the Maple Terrace Subdivisions in the City of Sycamore, DeKalb County, Illinois, including—

(1) Maple Terrace Phase I;
(2) Maple Terrace Phase II;
(3) Maple Terrace Phase III Unit 1;
(4) Maple Terrace Phase III Unit 2;
(5) Maple Terrace Phase III Unit 3;
(6) Maple Terrace Phase IV Unit 1;
(7) Maple Terrace Phase IV Unit 2; and
(8) Maple Terrace Phase IV Unit 3.

(c) REVISION OF FLOOD INSURANCE RATE LOT MAPS.—As soon as practicable after the date of the enactment of this Act, the Director of the Federal Emergency Management Agency shall revise the appropriate flood insurance rate lot maps of the agency to reflect the treatment under subsection (a) of the real property described in subsection (b).

SEC. 308. STUDY OF PARTICIPATION BY INDIAN TRIBES IN EMERGENCY MANAGEMENT.

42 USC 5121 note.

(a) DEFINITION OF INDIAN TRIBE.—In this section, the term ''Indian tribe'' has the meaning given the term in section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450b).

(b) STUDY.—

(1) IN GENERAL.—The Director of the Federal Emergency Management Agency shall conduct a study of participation by Indian tribes in emergency management.

(2) REQUIRED ELEMENTS.—The study shall—

(A) survey participation by Indian tribes in training, predisaster and postdisaster mitigation, disaster preparedness, and disaster recovery programs at the Federal and State levels; and

(B) review and assess the capacity of Indian tribes to participate in cost-shared emergency management programs and to participate in the management of the programs.

(3) CONSULTATION.—In conducting the study, the Director shall consult with Indian tribes.

(c) REPORT.—Not later than 1 year after the date of the enactment of this Act, the Director shall submit a report on the study under subsection (b) to—

Deadline.

(1) the Committee on Environment and Public Works of the Senate;

(2) the Committee on Transportation and Infrastructure of the House of Representatives;

(3) the Committee on Appropriations of the Senate; and

(4) the Committee on Appropriations of the House of Representatives.

Approved October 30, 2000.

LEGISLATIVE HISTORY—H.R. 707 (S. 1691):

HOUSE REPORTS: No. 106–40 (Comm. on Transportation and Infrastructure).
SENATE REPORTS: No. 106–295 accompanying S. 1691 (Comm. on Environment and Public Works).
CONGRESSIONAL RECORD:
Vol. 145 (1999): Mar. 4, considered and passed House.
Vol. 146 (2000): July 19, considered and passed Senate, amended.
Oct. 3, House concurred in Senate amendment with an amendment.
Oct. 5, Senate concurred in House amendment with an amendment.
Oct. 10, House concurred in Senate amendment.

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Appendix D:

State Agency Annual Report Form

Commonwealth of Virginia Standard Hazard Mitigation Plan
Mitigation Project Status

Report Date: _____
(Day/Month/Year)

Responsible Agency: _____

Street Address: _____

City/County: _____

Zip code: _____

Point of Contact: _____ Title: _____

Phone #: _____ E-mail address: _____

Mitigation Project Status:

Mitigation Project/Strategy Name:				
Project #:		**Goal #:**		
Description:				
Project Ranking:	**Critical** ☐	**High** ☐	**Medium** ☐	**Low** ☐
Project Status:	**Not Started** ☐	**Cancelled** ☐	**In progress** ☐	**Completed** ☐
	Please elaborate:			
If completed, were the goals and objectives achieved as planned? Yes ☐ No ☐ **Please elaborate:**				
If Started or Completed:	**Project Cost?** **$** _____	**Cost-effective?** Yes ☐ No ☐	**Project Funding Type** (please specify): **FEMA:** ☐ **Other/Federal:** **Other/Local:** Please specify if other: _____	
Indicator of Success (e.g., losses avoided)	**How many people were protected by this action?**			
	How many structures were mitigated?			
	Other indicators (i.e. losses avoided)?			
If no:	**Please elaborate (i.e. problems encountered):**			
Are the State Mitigation Goals still relevant? Yes No **Please elaborate:**				
Additional Comments:				

Appendix E:

Advisory Committee and Working Group Meeting Documentation

E1: Kickoff Meeting Committee Meeting Materials

There were two kickoff meetings: Advisory Committee Kickoff Meeting and Working Group Kickoff Meeting. The only difference in the presentation slides was the Advisory Committee voted on hazard identification and the Working Group reviewed the hazards chosen. The slides shown below are from the Advisory Committee meeting.

Commonwealth of Virginia Hazard Mitigation Plan Update

KICKOFF MEETING - ADVISORY COMMITTEE

FEBRUARY 27, 2017

WITT|O'BRIEN'S

Kickoff Meeting Agenda

WITT|O'BRIEN'S

- Welcome and Introductions
- Project Background and Purpose
- Overview of the Project
- Hazard Identification Exercise
- Capability Assessment Questionnaire (homework)
- Q&A and Next Steps

Introductions and Staffing

WITT | O'BRIEN'S

- Kelly George, Project Manager
- Erin Buchanan, Deputy Project Manager
- Jake Halley, GIS / HAZUS-MH Specialist
- Tom Malmay, Data Visualization Specialist

Background and Purpose

WITT | O'BRIEN'S

- Why are we updating this plan?
  - The current version of the Commonwealth of Virginia Hazard Mitigation Plan was approved by FEMA in 2013.
  - The approval is valid for 5 years and expires in 2018.
  - To avoid lapse in the approval status, the updated plan must be reviewed and approved by FEMA prior to the current plan's expiration.
- Why does the Commonwealth need a FEMA-approved hazard mitigation plan?
  - Certain federal funding is contingent on an approved hazard mitigation plan, including:
    - Hazard Mitigation Assistance funding
    - Public Assistance Categories C-G funding
    - Fire Management Assistance Grants funding

WITT | O'BRIEN'S

Overview of the Project

- What is hazard mitigation?
  - Any long-term measure undertaken to reduce or eliminate the risks posed by hazards to people or property.
  - Mitigation measures may be structural or non-structural.
- What is a hazard mitigation plan?
  - A plan that identifies the range of hazards that can affect the commonwealth and details ways to reduce the risk and exposure to hazards.
  - Mitigation plans form the foundation for the community's long-term strategy to reduce disaster losses and break the cycle of damage-repair-damage-repair.

WITT | O'BRIEN'S

Requirements for Hazard Mitigation Plan Updates

- Enabling Legislation:
  - The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Stafford Act), as amended by the Disaster Mitigation Act of 2000 (DMA2K)
    - This established the requirement for states, local governments, and other eligible applicants seeking hazard mitigation funding to develop, implement, and maintain an HMP in order to receive mitigation grant funding.
  - Codified by FEMA in 44 CFR, Part 201
  - State Mitigation Plan Review Guide 2016
- HMP Updates must build on the approved plan

Plan Update Process

WITT | O'BRIEN'S

- Established in FEMA 386
  - Organize resources
  - Assess risks
  - Identify priorities
  - Identify opportunities
  - Develop plan
  - Implement plan
  - Monitor plan



Advisory Committee Role

WITT | O'BRIEN'S

- The Commonwealth HMP Update Advisory Committee provides oversight to the plan update process and serves as a source of knowledge
- Contributions to the process include:
  - Attending planning meetings
  - Direct which hazards/threats are included
  - Providing knowledge and input, including questionnaires and surveys
  - Providing review and comment on drafts of plan update

WITT | O'BRIEN'S

Working Group Role

- The Commonwealth HMP Update Working Group serves as a source of knowledge and will help with data collection
- Contributions to the process include:
  - Attending planning meetings
  - Data collection
  - Providing local knowledge and input, including questionnaires and surveys
  - Providing review and comment on drafts of plan update

WITT | O'BRIEN'S

Required Elements for HMP Updates

- Hazard Identification and Profiles
  - Must address all possible hazards, not just the most likely to occur
    - Only natural hazards are required, though others are encouraged (but not reviewed)
    - Any hazard that is excluded must be justified
- Risk Assessment
  - Quantitative where possible
  - Should include future development where possible
  - GIS/mapping is not required by FEMA, but is strongly recommended
- We are required to address any changes to the hazards, risks, and vulnerabilities between the previous plan and the update
- Updated HIRA will address:
  - Future Conditions
  - Climate Change
    - Sea Level Rise
    - Changes to average temperatures
    - Increased potential for drought

WITT | O'BRIEN'S

Required Elements for HMP Updates (continued)

- Mitigation Strategy
  - Must address the vulnerabilities, risks, and hazards identified in the HIRA
  - Must address NFIP compliance
  - Identify any completed actions
- State Mitigation Capabilities
- Local Coordination and Mitigation Capabilities
- Plan review, evaluation, and implementation

WITT | O'BRIEN'S

Enhanced Plan

- What is an enhanced plan?
  - Documents a sustained and proven commitment of implementing a comprehensive hazard mitigation program
- Why does the Commonwealth of Virginia want to upgrade to enhanced plan status?
  - A state with a FEMA-approved enhanced plan status, at the time of a disaster declaration, is eligible to receive increased federal funding under the Hazard Mitigation Grant Program
    - 20% of the total estimated eligible Stafford Act disaster assistance

WITT|O'BRIEN'S

Enhanced Plan Requirements

- States that seek enhanced plan status must demonstrate they are already engaged in processes, activities, or initiatives that further risk reduction
- Enhanced Plans:
  - Meet required standard state plan elements
  - Demonstrate integrated planning
  - Document state mitigation capabilities
  - Document HMA grants management performance

WITT|O'BRIEN'S

Plan Review Process

- Commonwealth of Virginia HMP Update Advisory Committee recommends submittal of draft to FEMA for review
- FEMA has final review/approval authority; revisions may be requested
- When satisfied, FEMA issues a letter that the plan is approved pending adoption (APA)
- Commonwealth of Virginia adopts the plan and provides documentation of adoption to FEMA
- FEMA issues formal approval letter

WITT|O'BRIEN'S

Additions to Plan

- Loss avoidance study
  - Assess the effectiveness of two completed mitigation projects in the Commonwealth of Virginia.
    - Analyze return on investment by assessing avoided losses compared to a project's investment

WITT | O'BRIEN'S

Hazard Identification Exercise

- Task: to determine the final list of hazards to be considered in the Commonwealth of Virginia HMP Update and those hazards that will be excluded from further consideration
- Sources:
  - Commonwealth of Virginia Hazard Mitigation Plan 2013
  - FEMA 386



- Yes, Include



- Yes, Include



- Yes, Include

- Add Storm water/Urban Flooding
- Change Coastal Flood to Storm Surge
- Remove Tsunami through lack of historic occurrences

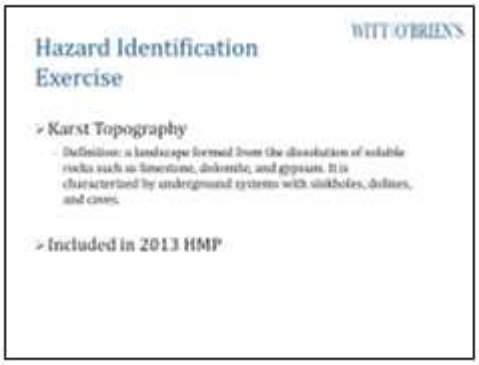


- Yes, Include

- Limited discussion on causes of failures with main emphasis on results



- Yes, Include



- Yes, Include



- Yes, Include



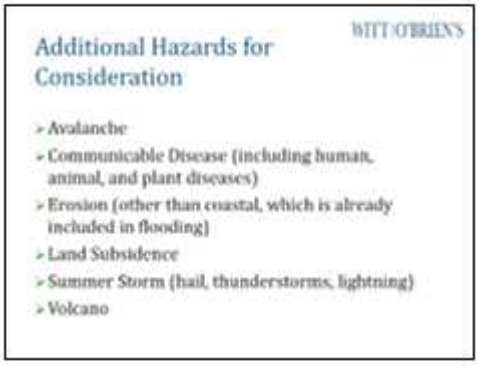
- Yes, Include



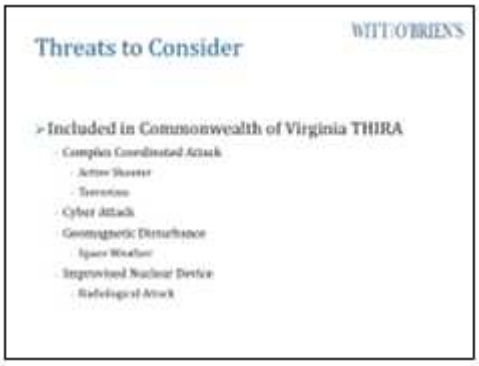
- Yes, Include



- Yes, Include

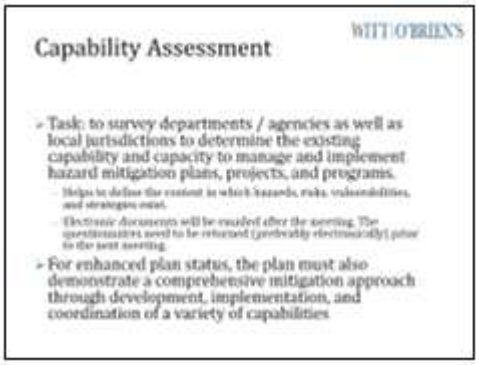


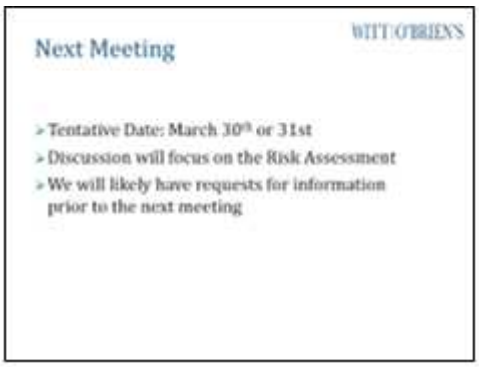
- Add Communicable Disease component with examples
- Add Land Subsidence associated with Aquifer issues (current USGS injection tests underway)
- Add Solar Storms/Solar Flares





- Yes, to Inclusions of HazMat







Questions?

WITT O'BRIEN'S

- Kelly George, Project Manager
  - [redacted]
  - 8138185429
- Erin Buchanan, Deputy Project Manager
  - [redacted]
  - 615.972.1418
- Jake Halley, GIS/HAZUS-MH Specialist
  - [redacted]
  - 318.381.3429
- Tom Malmay, Data Visualization Specialist
  - [redacted]

Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Kickoff Meeting- Advisory Committee

Date: February 27, 2017

Sign-in Sheet				
Sign or Initial	Name	Office/Department/Agency	Title	Email
	Kelly George	Witt O'Brien's	Project Manager	kgeorge@wittobriens.com
	Jake Halley	Witt O'Brien's	GIS/HAZUS-MH Specialist	jhalley@wittobriens.com
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Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Kickoff Meeting- Advisory Committee

Date: February 27, 2017

Sign-in Sheet				
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Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Kickoff Meeting- Working Group

Date: February 27, 2017

Sign-in Sheet				
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PBM	Paul Moye	United States Army Corps of Engineers	Civil Engineer	Paul.b.moye@usace.army.mil

Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Kickoff Meeting- Working Group

Date: February 27, 2017

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	Anne Smith	Virginia Institute for Marine Science		
	Jerry Stenger	University of Virginia State Climatology Office	STATE CLIMATOLOGIST	Pis2i@virginia.edu WX@VIRGINIA.EDU
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MCS	Mary Carson Stiff	Wetlands Watch	Director of Policy	Mc.stiff@wetlandswatch.org
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E2: Second Meeting: Advisory Committee and Working Group

Commonwealth of Virginia Hazard Mitigation Plan Update

MEETING #2 - ADVISORY COMMITTEE AND WORKING GROUP

JUNE 07, 2017

WITT|O'BRIEN'S
CONTROL THE OUTCOME

Meeting Agenda

ADVISORY COMMITTEE AND WORKING GROUP

WITT | O'BRIEN'S

WITT | O'BRIEN'S

Meeting Agenda

- Review of last meeting and status update
- Mitigation Strategy
  - Review goals
  - Review and update actions
- Capability Assessments
- Upcoming Schedule

Review of Last Meeting and Status Update

ADVISORY COMMITTEE AND WORKING GROUP

WITT | O'BRIEN'S

WITT|O'BRIEN'S

Review of Last Meeting and Status Update

- Review of Last Meeting
  - Hazard identification exercise
  - Capability assessment questionnaire homework
- Status Update
  - HIRA draft comments were due May 31, 2017
    - Revisions based on comments are underway
    - Final HIRA will be delivered to VDEM June 16, 2017
  - Mitigation Strategy and Capability Assessment draft sections will be completed June 09, 2017 and sent out to committee for review and comment.

Mitigation Strategy

ADVISORY COMMITTEE AND WORKING GROUP

WITT|O'BRIEN'S

WITT|O'BRIEN'S

Mitigation Strategy: Goals

- Mitigation plans are required to have goals as part of the strategy (44 CFR, 201.4(c)(3)(i).
- Goals are defined as broad policy statements that explain what is to be achieved.
- As a group, we will discuss the plan's existing goals and decide whether there is a need to make changes.

Mitigation Strategy: Goal 1

WITT | O'BRIEN'S

- Identify and implement projects that will eliminate long-term risk, directly reduce impacts from hazards, and maintain continuity of critical societal functions.

- Are there any updates needed for this goal? Yes. Add 'reduce or eliminate long-term risk'

Mitigation Strategy: Goal 2

WITT | O'BRIEN'S

- Incorporate mitigation concepts and objectives into existing and future policies, plans, regulations, and laws in the Commonwealth.

- Are there any updates needed for this goal? No changes.

Mitigation Strategy: Goal 3

WITT | O'BRIEN'S

- Improve the quality of the data and analysis used in the hazard identification and risk assessment process in state, local, and university hazard mitigation plans.

- Are there any updates needed for this goal? Yes. Change- Improve the quality and accessibility of the data used in the hazard identification and risk assessment and analysis process in state, multi-jurisdictional, and higher education hazard mitigation plans.

Mitigation Strategy: Goal 4

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- Through training, education, and outreach promote awareness of hazards, their risk, and potential mitigation actions in order to increase resiliency.
- Are there any updates needed for this goal? Yes. Promote and support a whole community approach to awareness of hazards, their risk, and potential mitigation actions in order to increase resiliency.

Mitigation Strategy: Actions

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- Mitigation plans are required to have actions as part of the strategy (44 CFR, 201.4(c)(3)(iii)).
  - An identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified.
  - **Mitigation Actions** are the specific steps (projects, policies, and programs) that implement the goals. They are highly focused, specific, and measurable.
- Actions must also identify current and potential sources of federal, state, local, or private funding to implement mitigation activities (44 CFR, 201.4(c)(3)(iv)).

Mitigation Strategy: Actions

WITT | O'BRIEN'S

- Prioritization Methodology for Actions
  - Prioritization criteria established (following slides)
  - Scoring system used to rank the action based on prioritization criteria (following slides)
  - Scores were tallied and rankings assigned to each project
  - We do not recommend making any changes to this methodology for this update
  - You will have the opportunity to make changes to the prioritization rankings during the mitigation strategy draft review process.

Mitigation Strategy: Actions

WITT | O'BRIEN'S

Criteria	Description
Human Health and Safety	Action protects human health, enhances public safety, protects vulnerable populations, or mitigates significant damage potential.
Continuity of Operations	Action protects the Commonwealth's ability to maintain continuity of operations, communications, critical infrastructure, and emergency management functions during a disaster.
Cost and Feasibility	Action is technically feasible and environmentally sound in terms of cost effectiveness, ability to be completed in a timely fashion, availability of expertise and technical support and ease of implementation.
Loss Reduction and Economic Recovery	Action will reduce long term financial losses and promote rapid economic recovery
Benefits Multiple Agencies and Organizations	Action benefits a number of groups, communities, or state agencies covering a large geographic area.
Multi-Hazard Mitigation	Action mitigates damage to critical resources from more than one hazard.
Focused Educational Efforts	Strategies for educational efforts will be carried out in a timely and relevant manner, messages are consistent, simple, and straightforward and in the appropriate media format, including alternative formats for people with special needs, and are directed toward people and property that are located within high hazard areas.

Mitigation Strategy: Actions

WITT|O'BRIEN'S

- Scoring system:
  - 0: Strategy met none of the criteria
  - 1: Strategy met some of the criteria
  - 2: Strategy met most of the criteria
- Scores will be tallied and assigned a ranking:
  - Low: 0-4
  - Medium: 5-7
  - High: 8-10

Capability Assessments

ADVISORY COMMITTEE AND WORKING GROUP

WITT|O'BRIEN'S

Capability Assessments

WITT|O'BRIEN'S

- Updates were made based on responses received.
- This section will be sent out for review on Friday June 9, 2017.

WITT|O'BRIEN'S

Upcoming Schedule

- Once the Capability Assessment, Mitigation Strategy, and HIRA sections are finished we will begin focusing on the local coordination and maintenance elements.
- Next meetings are tentatively scheduled for August 30, 2017

WITT|O'BRIEN'S

Questions?

- Kelly George, Project Manager
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  - 813.810.5429
- Erin Buchanan, Deputy Project Manager
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  - 615.972.1414
- Jake Halley, GIS/HAZUS-MH Specialist
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  - 318.381.3429
- Tom Malmay, Data Visualization Specialist
  - tmalmay@associates.wittobriens.com

Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Strategy and Capability Assessment Meeting- Advisory Committee

Date: June 7, 2017

Sign-in Sheet				
Sign or Initial	**Name**	**Office/Department/Agency**	**Title**	**Email**
	Kelly George	Witt O'Brien's	Project Manager	kgeorge@wittobriens.com
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	Matthew Wall	Virginia Department of Emergency Management		Matthew.wall@vdem.virginia.gov
	Edward Porner	Virginia Department of Emergency Management	Director, Recovery	Edward.porner@vdem.virginia.gov
	Richard Mortimer	Virginia Department of Emergency Management	Emergency Coordinator Fusion Center	Richard.mortimer@vdem.virginia.gov
	Brandon de Graaf	Virginia Department of General Services		Brandon.degraaf@dgs.virginia.gov

Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Strategy and Capability Assessment Meeting- Advisory Committee

Date: June 7, 2017

Sign-in Sheet				
Sign or Initial	**Name**	**Office/Department/Agency**	**Title**	**Email**
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	Anne Witt	Virginia Department of Mines, Minerals, and Energy	Geohazards Geologist	
	Matthew Heller	Virginia Department of Mines, Minerals, and Energy		Matt.heller@dmme.virginia.gov
	Shep Moon	Virginia Department of Environmental Quality (Coastal Planner)		Shep.moon@deq.virginia.gov
	Julie Langan	Virginia Department of Historic Resources		Julie.Langan@dhr.virginia.gov
	Hui-Shan Walker	Local Representative-Regions East		Hui-shan.walker@hampton.gov
	Jim Redick	City of Norfolk		James.redick@norfolk.gov
	Anna McRay	City of Richmond		mcr@henrico.us
	Bill Mahoney	Virginia Department of Emergency Management (Planning)	Director, Planning	William.mahoney@vdem.virginia.gov
✓	Mark Slaster	VDEM	JC Plans	mark.slaster@vdem.virginia.gov

Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Strategy and Capability Assessment Meeting- Working Group

Date: June 7, 2017

Sign-in Sheet				
Sign or Initial	**Name**	**Office/Department/Agency**	**Title**	**Email**
	Kelly George	Witt O'Brien's	Project Manager	kgeorge@wittobriens.com
	Erin Buchanan	Witt O'Brien's	Deputy Project Manager	ebuchanan@wittobriens.com
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	Paul Moye	United States Army Corps of Engineers	Civil Engineer	Paul.b.moye@usace.army.mil
	Emily Steinhilber	Old Dominion University		esteinhi@odu.edu
	Lean Abdelaziz	Virginia Department of Health		Lean.abdelaziz@vdh.virginia.gov
	Michelle Hamor	United States Army Corps of Engineers		Michelle.l.hamor@usace.army.mil
	Philip Stenger	[redacted]		wk@virginia.edu
	Mark Slauter	Virginia Department of Emergency Management (Flood/Dams)		Mark.slauter@vdem.virginia.gov
	Ernest Lott			
	Charley Banks	Virginia Department of Conservation and Recreation (National Flood Insurance)		Charley.banks@dcr.virginia.gov
	Mari Radford	Federal Emergency Management Agency	Community Planner Lead	Mari.radford@fema.dhs.gov
	Bill Sammler	National Weather Service-Wakefield		William.sammler@noaa.gov

Commonwealth of Virginia Hazard Mitigation Plan Update 2017
Strategy and Capability Assessment Meeting- Working Group

Date: June 7, 2017

Sign-in Sheet				
Sign or Initial	**Name**	**Office/Department/Agency**	**Title**	**Email**
	Chris Thompson	Virginia Department of Emergency Management (GIS)		Chris.thompson@vdem.virginia.gov
	LTC James Williams	Virginia Department of Military Affairs		James.v.williams22.mil@mail.mil
	William Mahoney	VDEM	Director, Plans	William.mahoney@vdem.virginia.gov
	Richard Mortimer			
	Steve Harrison	Virginia Department of Health (Radiological Health)		Steve.harrison@vdh.virginia.gov
	Mark Gaulkner			
	Stacy Neal	Secretary of Public Safety (Critical Infrastructure)		Stacie.neal@governor.virginia.gov
	Stewart Baker	Virginia Department of Emergency Management (Hurricanes)		Stewart.baker@vdem.virginia.gov
	Emily Steinhilber	ODU		
	Donna Pletch	VDEM		
	Donald Moye macops	VIMS	Coastal Scientist	dmoye@vims.edu

E3: Third Committee Meeting Materials: Advisory Committee and Working Group

The presentation content for both the Advisory Committee and Working Group meetings were the same; however, only the Advisory Committee presentation is provided below.

Commonwealth of Virginia Hazard Mitigation Plan Update

MEETING #3 - ADVISORY COMMITTEE

AUGUST 31, 2017

WITT|O'BRIEN'S
CONTROL THE OUTCOME

Meeting Agenda

ADVISORY COMMITTEE

WITT|O'BRIEN'S

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Meeting Agenda

- Review of last meeting
- Progress to date
  - Intro and Profile (Sections 01 and 02) – underway
  - HIRA (Section 03) - complete
  - Capability Assessment (Section 04) – complete
  - Mitigation Strategy (Section 05) – pending DHCD
  - Local Plan Integration (Section 06) – pending LAS
  - Plan Maintenance (Section 08) – complete
  - Loss Avoidance Studies – pending scheduling & completion
  - Appendices - underway
- Upcoming tasks
- Final Meeting

Review of Last Meeting

ADVISORY COMMITTEE

WITT | O'BRIEN'S

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Review of Last Meeting

- Review of Last Meeting
  - Capability assessment questionnaire – final opportunity to complete and submit
  - Reviewed and validated mitigation strategy goals
  - Reviewed the criteria for actions and activities included in the mitigation strategy
  - Reviewed and validated how actions and activities are scored/ranked in the mitigation strategy
  - Reviewed examples of actions and activities included in the mitigation strategy
  - Determined need for conference calls after AC review of proposed mitigation strategy
    - Calls conducted on June 26th and 28th

Progress to Date

ADVISORY COMMITTEE

WITT | O'BRIEN'S

WITT | O'BRIEN'S

Introduction (Section 01) & Commonwealth Profile (Section 02)

- Substantial completion occurred in July
- Sections will be finalized and QAQCed, but no further significant revisions are planned

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Hazard Identification & Risk Assessment (Section 03)

- Substantial completion occurred in June
- Section will be finalized and QAQCed, but no further significant revisions are planned

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Capability Assessment (Section 04)

- Substantial completion occurred in June
- Section will be finalized and QAQCed, but no further significant revisions are planned

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Mitigation Strategy (Section 05)

- Substantial completion occurred in June
- Full completion is pending additional information from DHCD
- Section will be completed, finalized, and QAQCed, but no further significant revisions are planned (only additions)

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Local Plan Coordination (Section 06)

- Substantial completion occurred in July and August
- Full completion is pending completion of loss avoidance studies
- Section will be completed, finalized, and QAQCed, but no further significant revisions are planned (only addition of LAS summaries)

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Plan Maintenance and Implementation (Section 08)

- Substantial completion occurred in August
- Section will be finalized and QAQCed, but no further significant revisions are planned

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Loss Avoidance Studies (Cities of Roanoke and Poquoson)

- VDEM data has been collected and analyzed, including:
  - Grant application data
  - Grant closeout data
  - NFIP data (claims, etc.)
  - Location data
- Post-mitigation data is pending collection, including:
  - Current status of mitigated properties
  - Damages and occurrences since mitigation
- Calculations of losses avoided remains pending
- Creation of visuals remains pending
- Drafting and finalization of study remains pending

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Appendices to Plan

- Appendix A – Acronyms
- Appendix B – Glossary
- Appendix C – DMA2K
- Appendix D – State Agency Annual Reports
- Appendix E – Meeting Documentation
- Appendix F – Local HMP Status
- Appendix G – Enhanced Plan Review Tool
- Appendix H – HMGP Admin Plan
- Appendix I – FEMA Approval Letter
- Appendix J – Commonwealth Adoption
- Appendix K – Threat Annex

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Appendix A (Acronyms)

- Substantial completion – scheduled for September 2017
- Section will be updated, finalized, and QAQCed, but no significant revisions are planned

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Appendix B (Glossary)

- Substantial completion – scheduled for September 2017
- Section will be updated, finalized, and QAQCed, but no significant revisions are planned

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Appendix C (DMA2K)

- Substantial completion – scheduled for September 2017
- Section will be updated, finalized, and QAQCed, but no significant revisions are planned

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Appendix D (State Agency Annual Reports)

- Substantial completion – scheduled for September 2017
- Section will be updated, finalized, and QAQCed, but no significant revisions are planned
- We will discuss these reports later in this meeting, as many people present will be tasked with completing and submitting them

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Appendix E (Meeting Documentation)

- Substantial completion – scheduled for October 2017
  - Section cannot be completed until after final meeting occurs in late September 2017
- Section will be updated, finalized, and QAQCed

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Appendix F (Local HMP Status)

- Substantial completion – scheduled for October 2017
  - Section will be completed as late as possible, to allow for inclusion of most current status of each plan
- Section will be updated, finalized, and QAQCed

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Appendix G (Enhanced Plan Review Tool)

- Substantial completion – scheduled for October 2017
  - Section cannot be completed until plan is completed, finalized, and QAQCed, as it requires final section, sub-section, and page numbers
- Section will be updated, finalized, and QAQCed

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Appendix H (HMGP Administrative Plan)

- Substantial completion – scheduled for October 2017
  - Section will be completed as late as possible, to allow for inclusion of most current version of the plan
- Section will be updated, finalized, and QAQCed

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Appendix I (FEMA Approval Letter)

- Section will be formatted only, as it cannot be finalized until the spring, when the plan is approved by FEMA
- Placeholders will be inserted and documents added upon receipt

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Appendix J (Commonwealth Adoption)

- Section will be formatted only, as it cannot be finalized until the spring, when the plan is adopted by the Commonwealth
- Placeholders will be inserted and documents added upon receipt

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Appendix K (Threat Annex)

- Initial drafting occurred in July
- Substantial completion scheduled for September
- Section will be finalized and QAQCed, but no further significant revisions are planned

Upcoming Tasks

ADVISORY COMMITTEE

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Upcoming Tasks - WOB

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- Finalization of Sections 01, 02, 05, and 06
- Creation of Section 07 (Enhanced Plan Status)
- Finalization/creation of Appendices
- Loss Avoidance Studies:
  - Site visit – City of Roanoke
  - Site visit – City of Poquoson
  - Calculation of losses avoided by mitigation
  - Drafting of loss avoidance studies

Upcoming Tasks – Advisory Committee

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- Final meeting – late September
- Delivery of complete plan draft – October 15th
- Comments on draft – November 3rd
  - This is a hard deadline that cannot be moved
  - Comments received after this date will not be included or addressed in the final draft
  - The review will take you some time to complete, so please plan and schedule accordingly
- Final draft of plan delivered to VDEM for submission to FEMA – November 14th

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State Agency Annual Reports

- Part of the plan implementation process is the completion of periodic reports as to progress
- Section 08 of the plan describes the completion and submission of annual reports, from state agencies to VDEM.
  - These reports detail and document progress on actions and activities
  - Reports are submitted to VDEM annually
  - VDEM compiles the reports, and will in turn report to the Advisory Committee at one of the bi-annual update meetings

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Final Meeting

ADVISORY COMMITTEE

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Final Meeting

- Scheduled for late September
  - Exact date pending; invitations will be issues as soon as date is confirmed
- Will provide update on progress to date
- Will provide update on timeline for project completion
- Will provide expected timeline for FEMA review/approval
- Will provide overview of Committee tasking post-plan approval

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Questions?

- Kelly George, Project Manager
  - Kgeorge@wittobriens.com
  - 813.810.5429
- Erin Buchanan, Deputy Project Manager
  - ebuchanan@wittobriens.com
  - 615.972.1414
- Tom Malmay, Data Visualization Specialist
  - tmalmay@associates.wittobriens.com

Commonwealth of Virginia Hazard Mitigation Plan Update 2018
Meeting 03 - Advisory Committee

Date: August 31, 2017 – 9am

Sign-in Sheet				
Sign or Initial	Name	Office/Department/Agency	Title	Email
	Banks, Charley	DCR	State Floodplain Coordinator	Charley.Banks@dcr.virginia.gov
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	DiCicco, Gina	DCR		Gina.DiCicco@dcr.virginia.gov
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	Pletch, Donna	VDEM	Planning	Donna.pletch@vdem.virginia.gov
EP	Pomer, Edward	VDEM	Recovery	Edward.Pomer@vdem.virginia.gov
MSW	Wall, Matthew	VDEM		Matthew.Wall@vdem.virginia.gov
ACW	Witt, Anne	DMME	Geologist	Anne.witt@dmme.virginia.gov

Commonwealth of Virginia Hazard Mitigation Plan Update 2018
Meeting 03 – Working Group

Date: August 31, 2017 – 1pm

Sign-in Sheet				
Sign or Initial	Name	Office/Department/Agency	Title	Email
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	DiCicco, Gina	DCR		Gina.DiCicco@dcr.virginia.gov
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	McCann, Donald	VIMS		dmccann@mrsnet.wittobriens.com
	Mortimer, Richard	VDEM	Planning	Richard.mortimer@vdem.virginia.gov
	Moye, Paul	USACE		paul.b.moye@usace.army.mil
	Neal, Stacie	Secretary of Public Safety	Critical Infrastructure	Stacie.Neal@governor.virginia.gov
	Pletch, Donna	VDEM	Planning	Donna.pletch@vdem.virginia.gov
MS	Slauter, Mark	VDEM	Floods/Dams	Mark.Slauter@vdem.virginia.gov
	Stohlfelber, Emily	Old Dominion University	Resilience	estohlfe@odu.edu
	Stiff-Carson, Mary	Wetlands Watch		mc.stiff@wetlandswatch.org
	Thompson, Chris	VDEM	GIS	Chris.Thompson@vdem.virginia.gov

Appendix F:

Local Hazard Mitigation Plan Information

Plan name	Year Updated	Expiration Date	Flood	Drought	Earthquakes	Geologic	Winter Weather	Fish Kills	Non-rotational wind	Tornadoes	Wildfire	Man Made
Accomack-Northampton Planning District Commission	2012	8/30/2022	High	Medium	Unranked	Unranked	Medium	Low	High	Low	Low	Low
Commonwealth Regional Plan	2016 Draft	5/14/2017	Medium	High	Unranked	Low	High	Unranked	High	Medium	Medium	Unranked
Central Shenandoah Planning District Commission	2013	12/18/2018	High	High	Low	Medium	High	Unranked	High	Medium	Medium	Low
Cumberland Plateau Planning District Commission	2013	11/14/2018	High	Medium	Medium	High	High	Unranked	High	High	High	Unranked
George Washington Regional Commission	2017	8/1/2017	High	Medium	Unranked	Low	High	Unranked	High	High	Medium	Unranked
Hampton Roads Planning District Commission	2017 (Draft)	4/30/2022	High	Low	Low	Medium	Medium	Unranked	High	Medium	Low	Medium
LENOWISCO Planning District Commission	2013	8/14/2019	High	High	Medium	High	High	Unranked	High	Medium	Medium	Unranked
Middle Peninsula Planning District Commission	2016	2/1/2022	High	Low	Low	Low	Medium	Unranked	High	Medium	Low	Unranked
Mount Rogers Planning District Commission	2011	2/14/2017	High	Medium	Low	Low	High	Unranked	Medium	Low	Medium	Unranked
New River Valley Planning District Commission	2011	4/3/2017	High	Medium	Low	Low	High	Unranked	High	Low	Low	Medium
Northern Neck Regional Planning Commission	2011	7/1/2017	Medium	Low	Unranked	Unranked	Medium	Unranked	High	Low	Low	Unranked
Northern Shenandoah Valley Regional Commission	2012	4/8/2018	High	Low	Low	Unranked	High	Unranked	High	High	Medium	Medium
Northern Virginia	2017	3/26/2022	High	Low	Medium	Low	High	Unranked	High	High	Low	Unranked
Rappahannock-Ripidan Regional Commission	2012	9/24/2017	High	Medium	Unranked	Low	High	Unranked	High	Unranked	Medium	Unranked
Region 2000 Partnership	2013	1/8/2018	High	High	Low	Low	High	Unranked	Medium	Medium	Medium	Low
Richmond-Crater Regional Planning Commission	2011	4/30/2017	High	Medium	Low	Low	Medium	Unranked	Medium	Unranked	Low	Medium
Roanoke Valley-Alleghany Regional Commission	2013	9/19/2018	High	Unranked	Low	Low	High	Unranked	Medium	Low	Medium	Unranked
Southside Planning District Commission	2013	5/13/2018	High	High	Low	Low	High	Unranked	High	High	Medium	Unranked
Thomas Jefferson Planning District Commission	2012	12/10/2017	High	Low	Low	Low	High	Unranked	Medium	Low	Low	Unranked
West Piedmont Planning District Commission	2016	2/9/2022	High	Medium	Low	Low	High	Unranked	High	Medium	Medium	Unranked

High	Medium	Low	Unranked

Appendix G:

State Enhanced Plan Crosswalk

B.1 Plan Review Tool Summary

State: Virginia	**Title and Date of Plan: Commonwealth of Virginia Hazard Mitigation Plan**	**Date of Submission:**
State Point of Contact (Name / Title): Donna Pletch- Strategic Planning Branch Chief	**Address: VDEM 10501 Trade Court North Chesterfield, VA 23236**	
Agency: Virginia Department of Emergency Management		
Phone Number: 804.897.9806	**E-Mail: Donna.pletch@vdem.virginia.gov**	

Date Received in FEMA Region:	
FEMA Reviewer (Planning – Name / Title):	**Date:**
FEMA Reviewer (HMA – Name / Title):	**Date:**
FEMA Reviewer (Name / Title):	**Date:**
FEMA Reviewer (Name / Title):	**Date:**
FEMA Approver (Name / Title):	**Date:**
Plan Status (Not Approved, Approvable Pending Adoption, Approved):	**Date:**

SUMMARY	**YES**	**NO**
STANDARD STATE MITIGATION PLAN		
Does the plan meet the standard state mitigation plan requirements?	X	
REPETITIVE LOSS STRATEGY		
Does the plan include a Repetitive Loss Strategy? [see S6 / RL1; S8 / RL2; S9 / RL3; S10 / RL4; S13 / RL5; and S15 / RL6]	X	
ENHANCED STATE MITIGATION PLAN		
Does the plan meet the enhanced state mitigation plan requirements?	X	

B.2 Standard State Mitigation Plan Regulation Checklist

REGULATION CHECKLIST – STANDARD PLAN *M=Met; NM=Not Met	Location in Plan	M / NM*
STANDARD (S) STATE MITIGATION PLAN		
Planning Process		
S1. Does the plan describe the planning process used to develop the plan? [44 CFR §§201.4(b) and (c)(1)]	2.1, 2.2	M
S2. Does the plan describe how the state coordinated with other agencies and stakeholders? [44 CFR §§201.4(b) and (c)(1)]	2.1, 2.2, 5.6	M
Required Revisions:		
Hazard Identification and Risk Assessment		
S3. Does the risk assessment include an overview of the type and location of all natural hazards that can affect the state? [44 CFR §201.4(c)(2)(i)]	3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20	M
S4. Does the risk assessment provide an overview of the probabilities of future hazard events? [44 CFR §201.4(c)(2)(i)]	3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20	M
S5. Does the risk assessment address the vulnerability of state assets located in hazard areas and estimate the potential dollar losses to these assets? [44 CFR §§201.4(c)(2)(ii) and 201.4(c)(2)(iii)]	3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20	M
S6. Does the risk assessment include an overview and analysis of the vulnerability of jurisdictions to the identified hazards and the potential losses to vulnerable structures? [44 CFR §§201.4(c)(2)(ii) and 201.4(c)(2)(iii)]	3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20	M
S7. Was the risk assessment revised to reflect changes in development? [44 CFR §201.4(d)]	3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20	M
Required Revisions:		
Mitigation Strategy and Priorities		

S8. Does the mitigation strategy include goals to reduce / avoid long-term vulnerabilities from the identified hazards? [44 CFR §201.4(c)(3)(i)]	5.2	M
S9. Does the plan prioritize mitigation actions to reduce vulnerabilities identified in the risk assessment? [44 CFR §§201.4(c)(3)(iii) and (iv)]	5.4, 5.5	M
S10. Does the plan identify current and potential sources of funding to implement mitigation actions and activities? [44 CFR §201.4(c)(3)(iv)]	5.5	M
S11. Was the plan updated to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities? [44 CFR §201.4(d)]	5.5	M
Required Revisions:		
State Mitigation Capabilities		
S12. Does the plan discuss the evaluation of the state's hazard management policies, programs, capabilities, and funding sources to mitigate the hazards identified in the risk assessment? [44 CFR §201.4(c)(3)(ii)]	4.1-4.7	M
Required Revisions:		

REGULATION CHECKLIST – STANDARD PLAN *M=Met; NM=Not Met	Location in Plan	M / NM*
Local Coordination and Mitigation Capabilities		
S13. Does the plan generally describe and analyze the effectiveness of local and tribal, as applicable, mitigation policies, programs, and capabilities? [44 CFR §201.4(c)(3)(ii)]	6.1, 6.2, 4.1-4.7	M
S14. Does the plan describe the process to support the development of approvable local and tribal, as applicable, mitigation plans? [44 CFR §§201.3(c)(5) and 201.4(c)(4)(i)]	6.3	M
S15. Does the plan describe the criteria for prioritizing funding? [44 CFR §201.4(c)(4)(iii)]	6.4, 7.3	M
S16. Does the plan describe the process and timeframe to review, coordinate, and link local and tribal, as applicable, mitigation plans with the state mitigation plan? [44 CFR §§201.3(c)(6), 201.4(c)(2)(ii), 201.4(c)(3)(iii), and 201.4(c)(4)(ii)]	6.3, 6.4, 6.5, 6.6, 7.2	M
Required Revisions:		
Plan Review, Evaluation, and Implementation		
S17. Is there a description of the method and schedule for keeping the plan current? [44 CFR §§201.4(c)(5)(i) and 201.4(d)]	8.1, 8.3.2	M
S18. Does the plan describe the systems for monitoring implementation and reviewing progress? [44 CFR §§201.4(c)(5)(ii) and 201.4(c)(5)(iii)]	8.2, 8.3	M
Required Revisions:		
Adoption and Assurances		
S19. Did the state provide documentation that the plan has been formally adopted? [44 CFR §201.4(c)(6)]		NM
S20. Did the state provide assurances? [44 CFR §201.4(c)(7)]		NM
Required Revisions:		
Repetitive Loss (RL) Strategy		
RL1. Did Element S6 (risk assessment) address RL and SRL properties? [44 CFR §§201.4(c)(2)(ii), 201.4(c)(2)(iii), and 201.4(c)(3)(v)]	3.10	M
RL2. Did Element S8 (mitigation goals) address RL and SRL properties? [44 CFR §§201.4(c)(3)(i) and 201.4(c)(3)(v)]	5.2	M
RL3. Did Element S9 (mitigation actions) address RL and SRL properties? [44 CFR §§201.4(c)(3)(iii) and 201.4(c)(3)(v)]	5.5	M
RL4. Did Element S10 (funding sources) address RL and SRL properties? [44 CFR §§201.4(c)(3)(iv) and 201.4(c)(3)(v)]	5.5	M
RL5. Did Element S13 (local and tribal, as applicable, capabilities) address RL and SRL properties? [44 CFR §§201.4(c)(3)(ii) and 201.4(c)(3)(v)]	6.9	M
RL6. Did Element S15 (prioritizing funding) address RL and SRL properties? [44 CFR §§201.4(c)(4)(iii) and 201.4(c)(3)(v)]	6.4	M
Required Revisions:		

B.3 Enhanced State Mitigation Plan Regulation Checklist

REGULATION CHECKLIST – ENHANCED PLAN *M=Met; NM=Not Met	Location in Plan	M / NM*
ENHANCED (E) STATE MITIGATION PLAN		
Meet Standard State Mitigation Plan Elements		
E1. Does the Enhanced plan include all elements of the standard state mitigation plan? [44 CFR §201.5(b)]	Throughout	M
Required Revisions:		
Integrated Planning		
E2. Does the plan demonstrate integration to the extent practicable with other state and/or regional planning initiatives and FEMA mitigation programs and initiatives? [44 CFR §201.5(b)(1)]	7.2	M
Required Revisions:		
State Mitigation Capabilities		
E3. Does the state demonstrate commitment to a comprehensive mitigation program? [44 CFR §201.5(b)(4)]	7.3, 7.6, 7.7	M
E4. Does the enhanced plan document capability to implement mitigation actions? [44 CFR §§201.5(b)(2)(i), 201.5(b)(2)(ii), and 201.5(b)(2)(iv)]	7.3, 7.4	M
E5. Is the state effectively using existing mitigation programs to achieve mitigation goals? [44 CFR §201.5(b)(3)]	7.5	M
Required Revisions:		
HMA Grants Management Performance		
E6. With regard to HMA, is the state maintaining the capability to meet application timeframes and submitting complete project applications? [44 CFR §201.5(b)(2)(iii)(A)]	7.3, 7.5	M
E7. With regard to HMA, is the state maintaining the capability to prepare and submit accurate environmental reviews and benefit-cost analyses? [44 CFR §201.5(b)(2)(iii)(B)]	7.3	M
E8. With regard to HMA, is the state maintaining the capability to submit complete and accurate quarterly progress and financial reports on time? [44 CFR §201.5(b)(2)(iii)(C)]	7.3, 7.5	M
E9. With regard to HMA, is the state maintaining the capability to complete HMA projects within established performance periods, including financial reconciliation? [44 CFR §201.5(b)(2)(iii)(D)]	7.3	M
Required Revisions:		

B.4 Strengths and Opportunities for Improvement

STRENGTHS AND OPPORTUNITIES FOR IMPROVEMENT
INSTRUCTIONS: The purpose of the "**Strengths and Opportunities for Improvement**" section is for FEMA to provide more comprehensive feedback on the state mitigation plan to help the state advance mitigation planning. The intended audience is the state staff responsible for the mitigation plan update. FEMA will address the following topics: 1. Plan strengths, including specific sections in the plan that are above and beyond the minimum requirements; and 2. Suggestions for future improvements. FEMA will provide feedback and include examples of best practices, when possible, as part of the *Plan Review Tool*, or, if necessary, as a separate document. The state mitigation plan elements are included below in italics for reference but should be deleted as the narrative summary is completed. FEMA is not required to provide feedback for each element. Required revisions from the **Regulation Checklist** are not documented in the **Strengths and Opportunities for Improvement** section. Results from the **Strengths and Opportunities for Improvement** section are not required for Plan Approval, but may inform discussions during the Program Consultation.
Describe the mitigation plan strengths, including areas that may exceed minimum requirements. ⎩ *Planning process* ⎩ *Hazard identification and risk assessment* ⎩ *Mitigation strategy* ⎩ *State mitigation capabilities* ⎩ *Local and tribal, as applicable, coordination and mitigation capabilities* ⎩ *Plan review, evaluation, and implementation* ⎩ *Adoption and assurances* ⎩ *Repetitive loss strategy, if applicable* ⎩ *Integrated planning process, if applicable* ⎩ *Commitment to a comprehensive mitigation program, if applicable* ⎩ *HMA grants management performance, if applicable*
Describe areas for future improvements to the mitigation plan. ⎩ *Planning process* ⎩ *Hazard identification and risk assessment* ⎩ *Mitigation strategy* ⎩ *State mitigation capabilities* ⎩ *Local and tribal, as applicable, coordination and mitigation capabilities* ⎩ *Plan review, evaluation, and implementation* ⎩ *Adoption and assurances* ⎩ *Repetitive loss strategy, if applicable* ⎩ *Integrated planning process, if applicable* ⎩ *Commitment to a comprehensive mitigation program, if applicable* ⎩ *HMA grants management performance, if applicable*

Appendix H:

State Administrative Plan

Hazard Mitigation Grant Program

HAZARD MITIGATION GRANT PROGRAM ADMINISTRATIVE PLAN

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PURPOSE

This appendix establishes the procedures for administration of the Hazard Mitigation Grant Program (HMGP) and for project management of the mitigation measures to be funded under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Act) as amended. It also establishes an independent grant program for hazard mitigation and is closely tied to the post-disaster hazard mitigation plan required by Section 322 of the Act as a condition of assistance.

ORGANIZATION

A. In compliance with 44 CFR 206.437 (b) (1), The Virginia Department of Emergency Management is the state agency responsible for the program administration. The Governor appoints a Governor's Authorized Representative who then employs a State Hazard Mitigation Officer (SHMO) {per 44 CFR 206.437 (b) (2)}. The SHMO and the Hazard Mitigation staff coordinates with the State Hazard Mitigation Committee to manage the Hazard Mitigation Grant Program (HMGP).

B. The following state agencies will designate representatives on the State Hazard Mitigation Committee and participate in the State Hazard Mitigation Program. Other state agencies may be requested to provide a representative to the State Hazard Mitigation Committee should the risk assessment or a disaster impact on their area of responsibility.

1. Department of Environmental Quality
2. Department of Agriculture and Consumer Services
3. Department of Transportation
4. Department of Health
5. Department of Conservation and Recreation
    a. Floodplain Management Program
    b. State Parks Division
6. Department of Forestry
7. Department of Mines, Minerals and Energy
8. Department of Housing and Community Development.
9. Department of Historic Resources
10. State Corporation Commission (Bureau of Insurance)
11. Department of General Services
12. State Universities
13. Attorney General's Office

CONCEPT OF OPERATIONS

A. Prior to a disaster declaration, the State Hazard Mitigation Officer (SHMO) will participate in the disaster declaration process by coordinating the state hazard mitigation part of the federal/state Preliminary Damage Assessment (PDA) process. Other state agency and Virginia Department of Emergency Management (VDEM) reservist personnel will be trained to perform in-the-field PDA duties by the Recovery and Mitigation Division. Staffing requirements will be determined following each declaration, based on the scope and magnitude of the disaster and available budget resources – 44 CFR 206.437 (b) (3).

B. Following a major disaster declaration by the President authorizing hazard mitigation assistance, a FEMA/State Agreement will outline the 75/25 cost-share provision of the Hazard Mitigation Grant Program. The agreement will further state that the nonfederal share may exceed the federal share and may be a combination of state, local, and private funding.

C. The State Coordinating Officer (SCO) will submit a Letter of Intent to the Regional Administrator indicating that the state intends to access funds under section 404 of the Stafford Act (HMGP). The letter of intent shall be transmitted within 60 days of the declaration. The Letter of Intent may not be required if the disaster declaration request to the President from the Governor includes a request for Hazard Mitigation.

D. The SHMO, in consultation with the SCO, representatives of other state agencies (see above) and the Hazard Mitigation Officer (HMO) will develop a written mitigation strategy that identifies mitigation opportunities and establishes priorities for funding. The strategy document will receive the endorsement of the SCO and the Federal Coordinating Officer (FCO). This document, once endorsed, will be added as an update to the State Hazard Mitigation Plan.

E. The SHMO will continue administration of the Hazard Mitigation Grant Program after the Joint Field Office (JFO) closes. The number and size of projects under development will determine the staffing. Under certain circumstances such that a disaster event exceeds the capabilities of the State to implement any mitigation function, the State may, through FEMA, contract assistance.

F. Identification and Notification of Potential Applicants {per 44 CFR 206.437 (b) (4i)}

1. Identification

a. Eligible applicants anywhere in the State may apply for HMGP grants following a declaration of disaster. Applications are not limited to declared localities, or the hazard for which the disaster was declared. Priority will be given to the designated localities depending on the nature and extent of the disaster.

b. Upon declaration of the disaster, the SHMO and Hazard Mitigation staff, in consultation with the HMO, will participate in the PDA process for early

indications of possible hazard mitigation opportunities. The state/federal Hazard Mitigation staff may conduct hazard mitigation surveys immediately after a disaster is declared. The SHMO and HMO will coordinate with the state and FEMA staff in the initial assessments. They will also try to obtain a preliminary estimate of available program funds.

c. Based on the damage surveys and the goals and objectives set forth in the State Hazard Mitigation Plan, the SHMO will create an initial mitigation strategy report. The report will be written within 30 days of the declaration and will outline a strategy to identify and implement mitigation opportunities for the disaster-stricken areas. This initial strategy will aid in determining the final disaster strategy in cases where the disaster requires more time to determine impact and needs.

d. The SHMO will review and revise, if necessary, the existing State Hazard Mitigation (322) Plan for potential applications of Section 404 funding.

e. The SHMO and Hazard Mitigation staff will identify potential applications. The mechanism for establishing funding priorities will be the mitigation strategy.

f. Potential applicants will continue to expand as recovery efforts progress and the Mitigation Strategy for the current disaster is developed.

2. Notification

a. Based on the particulars of the disaster, a joint FEMA/VDEM press release describing the program may be developed and issued. It will include a point of contact for obtaining additional program details; and may include an announcement of Section 404 briefings to be held in the areas.

b. The SHMO, GAs, and Public Assistance (PA) Officer may also participate in briefings for applicants for the infrastructure program (406) and in training sessions for the inspectors in both the infrastructure (406) and human services (408) programs. The purpose of these activities is to alert all disaster assistance personnel and potential assistance applicants to be aware of possible mitigation opportunities. This briefing is only to generate awareness of the program, not give a detailed overview.

3. Specific Mitigation Briefing {per 44 CFR 206.437 (b) (4ii)}

a. The SHMO and GAs may also conduct specific mitigation briefings for potential applicants (local officials, citizens, or communities). The briefing will include:

1. General overview of mitigation programs including mitigation opportunities under federal Disaster Assistance Sections 404 and 406.

2. Specific information about 404 HMGP including:

a) Eligibility

b) State mitigation priorities

c) The application process

d) The selection process

e) Project management

f) Technical assistance

g) Nature of funding

h) Key deadlines

3. During the briefing, potential applicants will be given a "Pre-Application Package" consisting of the following:

a) HMGP regulations and guidelines, including eligibility criteria, types of projects, key deadlines, and a contract for additional information

b) Pre-application form (HMGP)

c) State identified priorities

b. The SHMO and GAs will notify potential applicants about the mitigation briefing(s) via direct contact and through the public media.

G. Pre-application Procedures {per 44 CFR 206.437 (b) (4ii)}

1. Potential applicants will have at least 15 days following the date of the HMGP specific briefing to notify the SHMO and GAs of their interest in applying for a grant and designate an individual as the "Sub-recipient's Authorized Representative" to administer the grant program at the local level. The deadline for notification of interest will be set by the SHMO and published at the briefing. The applicants shall submit a completed HMGP Pre-application form as notification. The time limitation may be extended by the SHMO when justified and requested in writing by the applicant.

2. Upon receipt of the above-mentioned forms, the SHMO and GAs, will perform an eligibility review and notify potential applicants via written correspondence of their eligibility status.

a. Those applicants whose pre-applications were deemed eligible will receive a letter of eligibility with the Application Form and other pertinent information enclosed.

b. Those applicants whose pre-applications were determined ineligible will be offered technical assistance/advice regarding how to achieve program eligibility.

1. Technical assistance to potential applicants will be based on need and availability of personnel. If required technical assistance is not resident at the State level, such assistance will be requested from FEMA {per 44 CFR 206.437 (b) (4x)}.
2. Submission dates and response times will be included in all applicant notices, briefings and requests for additional information.

H. Application Procedures {per 44 CFR 206.437 (b) (4ii)}

1. The SHMO and GAs will have the primary responsibility for ensuring that all applications are properly completed. Each application must contain the following information.

a. Name of Sub-recipient

b. State or local contact for the project

c. Location of the project

d. Description of the project/ (Scope of Work)

e. Line-item project budget

1. Must show non-federal match amount and type (cash or in-kind)

f. Analysis of the projects cost effectiveness and substantive risk reduction, consistent with Section 206.434 of Federal 404 Regulations

g. Work schedule and maintenance agreement

h. Justification for selection

i. Alternatives considered

j. Environmental information consistent with 44 CFR 9, Flood Management and Protection of Wetlands; and 44 CFR 10, Environmental Considerations; and in compliance with Executive Order 12898, Environmental Justice; Executive Order 11988, Floodplain Management; Executive Order 11990, Protection of Wetlands; and the National Environmental Policy Act (NEPA)

k. Historic information consistent with local, state, and federal historic preservation guidelines to include the National Historic Preservation Act.

l. Coordination with the US Army Corps of Engineers (USACOE) and the Virginia Department of Transportation (VDOT) to insure no planned projects are currently under consideration that would impact proposed mitigation projects or locations.

m. Prioritization plan, if necessary

n. Disk including the electronic version of the completed HMGP application form

o. All applicable maps of project locations

p. Assurance of project maintenance

q. Other pertinent information if necessary

1. Completed property owner participation forms
2. Property substitution list

r. Documentation of meeting local plan requirements

2. The date for submission of the application will be established by the SHMO. Applicants will have at least 60 days following receipt of the SHMO letter stating their eligibility. The SHMO may give extensions upon written request.

3. Upon receipt of a project application, the SHMO and Grants Branch staff will assign a Project Identification Number (PIN) to each application. The PIN will consist of the FEMA disaster number and a project number.

4. The SHMO will consult with appropriate state agency representatives and peer reviewers on through the Finance Division/Grants Branch process to review each application for eligibility in accordance with applicable regulations of the HMGP. The SHMO, and Grants staff are responsible for obtaining any additional information necessary to make the determination and for notifying applicants of ineligible projects or proposed project status.

5. In the event that several eligible projects are competing for limited funding, applications submitted to FEMA will be made in accordance with priorities established in the Mitigation Strategy and by the grant stakeholder reviewers.

6. The SHMO is responsible for preparing a complete application, signed by the GAR, which must include a Standard Form (SF) 424, Applications for Federal Assistance, and SF 424D, Assurances for Construction Programs if appropriate, and a narrative statement to support the package being transmitted to FEMA.

7. The application may be amended by the state to include measures identified subsequent to the initial application. All supplements identifying new mitigation measures to the application must be made within 90 days of FEMA approval of the Section 322 Mitigation Plan and must contain information as noted in the above section H.1.

8. The SHMO and/or GAs will establish contact with all the Sub-recipient's Authorized Representatives and provide technical assistance and project management overview to the Sub-recipients for the duration of the project. Technical expertise and guidance can be obtained through the SHMO, State Hazard Mitigation Committee, and Hazard VDEM Grants Branch.

9. Time limitations on applications may be extended by the FEMA Regional Administrator when justified and requested in writing by the GAR.

10. The SHMO will notify the applicants and the HMO of funding requests.

I. Determining Eligibility {per 44 CFR 206.437 (b) (4iii)}

1. The following are eligible to apply for the Hazard Mitigation Program Grant:

   a. A state agency, local government or university

   b. A private nonprofit organization that provides essential government services

   c. An Indian tribe or authorized tribal organization

   d. Applicant must have a FEMA approved Local Hazard Mitigation Plan (322)

2. The SHMO will determine eligibility of the applicant and that minimum program requirements are met by ensuring that each application contains:

   a. A reference to the specific section of the State Hazard Mitigation Plan to which the proposed project relates

   b. A narrative describing how the project benefits the designated disaster area

   c. A completed environmental and historic review as required by FEMA {per 44 CFR 206.437 (b) (4)(iv)} using guidelines and input established by FEMA, EPA, Virginia Department of Historical Resources, Virginia Department of Environmental Quality and/or other agencies as is appropriate and in all cases of the structure being in excess of 50 years of age.

   d. NFIP participation requirement and compliance with Executive Order 11988, Floodplain Management and Executive Order 11990, Protection of Wetlands.

   e. Information sufficient to determine the extent to which the project will solve the problem it is intended to address and the status of any associated dependent or supporting projects.

   f. Applicant should state compliance with all applicable federal, state and local codes.

1. A brief history of previous occurrences of the problem the project addresses, including dates and impact of each occurrence or an analysis of projected potential damages if the hazard is not addressed.

2. Documentation comparing the proposed project and a listing of influencing factors.

3. An estimate of the effective life of the project and a listing of influencing factors.

4. An analysis of any pertinent demographic and physical changes to the area or facility to be protected by the project and description of any future maintenance or modifications the project may involve.

5. A cost analysis to determine whether the benefits to be gained are at least equal, if not greater then, the cost of the project.

J. Project Selection {per 44 CFR 206.437 (b) (4)(v)}

1. If it is necessary to select from a range of projects due to funding or other constraints, the SHMO, in consultation with the State Hazard Mitigation Committee and grant stakeholder reviews, using the State Hazard Mitigation Plan, will evaluate and prioritize all eligible applications. This ranking will be in accordance with the mitigation strategy established for the disaster and criteria in 44 CFR Sections 206.434(b) and 206.435(b) and (c) as follows:

    a. Measures that best fit within an overall plan for development and/or hazard mitigation in the community, disaster area, or state.

    b. Measures that, if not taken, will have a detrimental impact on the applicant, such as potential loss of life, loss of essential services, damage to critical facilities, or economic hardship on the community.

    c. Measures that have the greatest potential impact on reducing future disaster losses.

    d. Measures that are designed to accomplish multiple objectives, including damage reduction, environmental enhancement, and economic recovery.

2. The SHMO and State Hazard Mitigation Committee and grant stakeholders will take into consideration optimizing the total amount of funding available, including overmatching of federal funds with nonfederal funds, when developing this ranking.

3. The SHMO and State Hazard Mitigation Committee/ peer reviewers will also consider the level of interest and demonstrated degree of commitment of each applicant.

K. Project Management {per 44 CFR 206.437 (b) (4)(vii)}

1. The State, as the recipient, has primary responsibility for project management and accountability of funds as indicated in 44 CFR Part 13 and 206 and for ensuring that all program and administrative requirements are met as indicated in 44 CFR Part 13 and 206 and the HMA Unified Guidance as applicable to HMGP projects.

    a. Payment of funds to the Recipient or Sub-recipient for any HMGP grant is through a Reimbursement Process with the rare and occasional exception of Advance Payments as allowed under 44 CFR 13.21(c) and per 44 CFR 206.437(b)(4)(vi) when determined to be required and necessary for the project to proceed.

    b. All Reimbursement Requests will be handled in a timely and effective manner in compliance with Virginia Prompt Pay requirement and in accordance to 44 CFR 13.21 (b).

    c. Period of Performance for all Hazard Mitigation Grants is typically no more than three years. If an extension is needed, paragraph 4 of this section will apply.

2. Progress Reports {per 44 CFR 206.437(b)(4)(xii)}

    a. The sub-recipient shall provide VDEM with quarterly reports and a final report on the progress of work set forth in the Scope of Work. The quarterly reports and final report shall contain the following components: (1) a narrative describing in detail the progress of the sub-recipient in fulfilling the provisions of the Scope of Services; (2) Reimbursement Requests {per 206.437 (b) (4vi)} as needed which itemize the expenses incurred by the sub-recipient, including separate columns for the federal, state and the sub-recipient's matching contribution to the total cost of services as reflected in the Project Budget; and (3) the schedule of specific project tasks with target completion dates and actual completion dates. The first quarterly report is due to VDEM at the end of the first quarter following the award of the grant.

Reporting Period	Report Due to VDEM
January 1 – March 31	no later than April 15
April 1 – June 30	no later than July 15
July 1 – September 30	no later than October 15
October 1 – December 31	no later than January 15

    b. Sub-recipient quarterly reports for all active, approved projects will be used by VDEM to compile the required progress reports for FEMA. This report will be submitted to the FEMA Regional Administrator no later than the last day of the month (January, April, July and October) immediately following each federal fiscal quarter in compliance with the federal audit requirements of 44 CFR part 13.41.

3. Recipient Oversight

   a. VDEM has a project management guide that is distributed to all communities with a FEMA-Commonwealth grant.

   b. In conjunction with the project management guide, VDEM maintains a monthly call policy for all projects and a quarterly site visit policy for structural projects.

   c. To reinforce federal and state partnership, VDEM encourages FEMA Region III personnel participation with VDEM in local site visits. VDEM reviews and updates their project oversight and documentation process based on any statutory changes and input from FEMA.

   d. In the event of breach of the grant agreement by the sub-recipient, VDEM shall provide written notice to the sub-recipient specifying the manner in which the Agreement has been breached. If a notice of breach is given and the sub-recipient has not substantially corrected the breach within sixty (60) days of receipt of the written notice, VDEM shall have the right to terminate the Agreement. The sub-recipient shall be paid for no service rendered or expense incurred after receipt of the notice of termination, except such fees and expenses incurred prior to the effective date of termination that are necessary for curtailment of its work under the Agreement. Termination of this agreement can occur as an effect of one of two results: First, as a result of the proper completion and closeout of this project. Second, termination may occur as a result of *Termination for Convenience* or other termination as allowed or required by 44 CFR 13.44 for projects which cannot be completed as described in the FEMA-approved grant project application and the Scope of Work. Communication of this decision and information related to the project termination will be provided to the sub-recipient in coordination with FEMA through registered mail.

4. Time Extensions

   a. The typical maximum period of Performance for a HMGP project is three years. Requests for time of performance extension must be received in writing by VDEM within 75 days of project termination date with reasons for requested time of performance extension and a revised Milestone Table. The request must include:
      1. Federal HMGP Project Identification Number;
      2. Reason(s) for the delay;
      3. Current project completion status, to include funds spent to date;
      4. Original scheduled completion date;
      5. New scheduled completion date; and
      6. Dates and provisions or any previous extensions

   b. Requests for extensions will be forwarded along with the GAR's recommendation to FEMA at least 60 days prior to the end of the project performance period.

c. If a second time extension is required a request will be forwarded to FEMA along with the GAR's recommendation at least 60 days prior to the end of the extended period of performance period. This request must include all criteria listed under paragraph a. of this section.

5. Cost Overruns and Duplication of Benefits {per 44 CFR 206.437(b)(4)(viii)

a. In the event that during the execution of work on an approved mitigation measure, if actual project costs are exceeding the approved estimates, the sub-recipient shall advise the GAR in writing and furnish appropriate justification for the overrun.

b. The GAR or designee shall evaluate each cost overrun. Those cost overruns which can be met without additional federal funds, or which can be met by offsetting cost under-runs on other projects, may be approved by the GAR so long as the full scope of work on all affected projects can still be accomplished. Requests that are not justified will be denied by the GAR.

c. For justifiable cost overruns which exceed previous federal project obligations and require additional funds, the GAR shall submit a request with a recommendation to the FEMA Region III Administrator for a determination. The sub-recipient's justification for additional costs and other pertinent material shall accompany the request. Cost overruns can only be funded by identifying an equivalent cost underrun in a previously approved mitigation project under that same disaster assistance appropriation or through the "unobligated funds" process. Cost overrun notifications must be accompanied by a new BCA. If the new analysis does not generate a benefit-cost ratio equal to or greater than one (1.0) the cost overrun will not be considered justifiable. Federal funds will not be available to meet the cost overrun.

d. The Regional Administrator shall notify the GAR in writing of the determination and process a supplement, if necessary.

e. VDEM shall work with FEMA and Sub recipients to identify possible Duplication of Benefits issues. When discovered, care shall be taken to assure that there are no inappropriate reimbursements that will create a situation whereby funds would have to be refunded to FEMA. If a project has closed and discovery of duplication of benefits is found, VDEM will work with FEMA to recover those funds.

f. Problems or circumstances affecting project costs shall also be identified through the required quarterly progress reports.

6. Scope of Work Changes

a. Through the SHMO and GAs, the sub-recipient will notify the GAR of any perceived, necessary change to the original scope of work as soon as identified. This written notification must include:

1. Federal HMGP Project Identification Number;
2. Reason(s) for the change as supported by appropriate justification and any relevant documentation: e.g., photographs, standards, etc.;
3. Estimate of the change in cost and referencing the original budget;
4. Current project status, to include funds spent to date;
5. Original schedule and completion date;
6. New projected schedule and completion date.

b. The SHMO and GAs will evaluate the proposed change(s), review it with the GAR and, if necessary, ask FEMA to perform a technical engineering review.

c. The change request and GAR's recommendation will be submitted to FEMA after evaluation of all available information. If FEMA's engineering expertise is required, the GAR will defer recommendation to that agency.

7. Compliance Monitoring

a. As projects are identified "complete" either through contact with the sub-recipient, review of quarterly reports, or site visits, GAs will prepare a Locality Reconciliation Form to help the sub-recipient prepare for the state's final site visit. Within this form, the sub-recipient is asked to verify receipt of funds and expenditure of non-federal match. Concurrent with sending out the Local Financial Reconciliation form, for structural projects GAs will scheduling the final site visit with the locality.

b. The site visit includes a site inspection for mitigation program compliance, a review of financial records, and a review of programmatic records. VDEM staff takes digital pictures of each mitigation project structure during the visit and any other relevant areas that will be benefited by the mitigation project. Documents gathered during the site visit, if not previously submitted to VDEM, include:

1. Digital photographs of mitigated structures, infrastructure, affected area;
2. Signed verification of financial reconciliation between VDEM and the sub-recipient;
3. Latitude and Longitude;
4. Documents produced as defined within the Scope of Work;
5. National Flood Insurance Program policy verification;
6. Elevation Certificates;
7. Copies of deeds and restrictions on those deeds and;
8. Other pertinent documents or information as project required.

c. All acquisition projects will be monitored every three (3) years to ensure the integrity of the "open space in perpetuity" provisions of 44 CFR Part 80.19.

8. The Sub-recipient, under the guidance of the State as Recipient, is responsible for the management of the individual project grants in accordance with applicable federal, state, and local regulations {per 44 CFR 206.437(b)(4)(xi)}.

   a. The Sub-recipient will designate a local point of contact individual to serve as the "Sub-recipient's Authorized Representative." This individual will be responsible for the local administration of the individual project grants.

   b. Procurement of contractors and other goods and services by the Sub-recipient for the completion of approved projects will be in accordance with their own standard procurement procedures, provided they are in compliance with applicable federal law and the standards found in the 44 CFR 13.36.

   c. The Recipient and Sub-recipient will retain all project appropriate records and documents for a period of three years after the completion of the project.

   d. Uniform audit requirements as set forth in 44 CFR Part 13, 44 CFR Part 206, and 2 CFR 200 (the "Supercircular") apply to all projects under the Hazard Mitigation Grant program. FEMA may elect to conduct a federal audit on projects funded under this program.

   e. FEMA, the Comptroller General of the United States, and the Commonwealth of Virginia, or their authorized representatives shall have the right of access to any records relevant to the grant or sub-grant for as long as the records are retained.

   f. Sub-recipients will submit quarterly reports to the SHMO and GAs on the status and completion date of their projects in sufficient time to allow the GAR to compile a quarterly progress report for FEMA. These reports will identify any problem areas that may result in noncompliance with the approved grant conditions to include known or anticipated cost overruns. Sufficient time is defined as at least two weeks.

   g. The GAR will submit a request, with recommendation, to the FEMA Regional Administrator for project cost changes exceeding or totaling over 10 percent of the approved project cost. The Regional Administrator will notify the GAR in writing the final determination and process a supplement, if necessary.

   h. As a component of the closeout, the GAR shall submit certification to the Regional Administrator of expenditures for each approved project upon its completion. With this submission, the GAR certifies that the reported costs were incurred in performance of eligible work, that the approved work was completed and that the project was completed in compliance with the provisions of the FEMA-State Agreement.

1. The Sub-recipient will provide the GAR, through the SHMO, certification of the project completion in accordance with the specifications contained in the approved project application or approved and amended project supplements.
2. The SHMO and Grants Branch staff will perform a final inspection of the individual projects to be performed to insure the completion of the project is in accordance with the specifications contained in the approved project application.

9. Allowable Costs

a. General policies and guidelines for determining allowable costs are established in 2 CFR 200. Cost guidelines not covered in these referenced OMB Circulars are set forth in 44 CFR Part 206, Subpart N, and Section 206.439. All Recipient and Sub-recipient accounting procedures must conform with generally accepted accounting principles (GAAP).

10. The State will retain the entire amount of the management cost allocation made available for major declaration as it is assumed that the majority of the sub recipient costs will be captured in the Project Application Scope of Work and Budget process. One hundred percent (100%) of all federal Management Cost funds available shall be kept at the State level with no pass-through funds being allocated to the Sub-recipient {per 44 CFR 206.437 (b) (4)(xiii)}.

11. State management costs for personnel assigned to administer the Hazard Mitigation Grant program in the Joint Field Office (JFO) may be eligible when approved by the Regional Administrator.

12. Appeals {per 206.437 (b) (4ix)}

    a. The recipient may appeal any determination made related to federal assistance. Appeals will be filed in accordance with 44 CFR 206, Subpart N – Hazard Mitigation Grant Program.

    b. An applicant or sub-recipient may file, with the recipient, an appeal of any determination previously made related to federal assistance for an applicant or sub-recipient.

    c. Appeals filed by applicants or sub-recipients must be in writing and supported by sufficient documentation (new and compelling information) justification to allow the GAR to make a determination of validity and make a decision on the first appeal.

13. After review by the SHMO and GAR, if the appeal appears valid, the letter will be processed and forwarded to FEMA for review and determination.

14. If the SHMO, GAR, or FEMA deny the appeal, the actions outlined above in paragraphs 13.b and 13.c above will apply to any second appeal. The second appeal should include new or expanded information to support the need for a second appeal. The second appeal must be made within 60 days of the decision. The decision on the second appeal, whether made by the SHMO, GAR, or FEMA is final.

15. Technical Assistance {per 44 CFR 206.437(b)(4)(x)}

    a. Upon receipt of a FEMA Award letter, the SHMO and GAs compile an award package. This package includes an award letter from the Governor's Appointed Representative, a contract document, and a copy of 2 CFR 200. The award letter, references these documents and the sub-recipient's obligation to comply, as does VDEM, with all administrative requirements of the *Code of Federal Regulations*. The sub-recipient is directed to review all documents and return the executed contract document along with a revised project implementation schedule within 30 days of receipt of the award package.

    b. Upon receipt of the executed award package, the VDEM mitigation project specialist assigned to the management of the sub-grant conducts a project implementation meeting at the office of the project sponsor. At this meeting, all aspects of project implementation are discussed. The sponsor is provided with copies of quarterly report and financial reimbursement forms. In addition, a field site visit may be conducted to familiarize the VDEM mitigation project specialist with the project specifics.

    c. The GAs have developed many different training workshops and presentations. VDEM can develop or present an already created session on many mitigation project development and implementation topics at the request of the sub-recipient.

AUTHORITIES AND REFERENCES

A. Federal

1. Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288, as amended, Sections 404 and 322).

2. Public Law 93-234, as amended, Flood Disaster Protection Act of 1983.

3. Single Audit Act Amendment of 1996.

4. FEMA Regulations, 44 CFR, Part 206, Subparts M and N.

5. FEMA Regulations, 2 CFR Part 200 , Uniform Administration Requirements for Grants and Cooperative Agreements to State and Local Governments.

6. FEMA Regulations, 2 CFR Part 200, Administration of Grants: Audits of State and Local Governments.

7. Executive Order 11988, Floodplain Management.

8. Executive Order 11990, Protection of Wetlands.

9. Executive Order 12612, Federalism.

10. Executive Order 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction.

11. Executive Order 12898, Environmental Justice.

12. Office of Management and Budget Memorandum, Nonstructural Flood Protection Measures and Flood Disaster Recovery, July 10, 1980.

13. Interagency Agreement for Non-Structural Damage Reduction, December 15, 1980 as updated September 30, 2001.

14. Title 2: Grants and Agreements:

    a. Cost Principles for Educational Institutions - 2 CFR 220 as of October 22, 2009.
    b. Cost Principles for State, Local, and Indian Tribal Governments – 2 CFR 225 as of October 22, 2009.
    c. Cost Principles for Non-Profit Organizations – 2 CFR 230 as of October 22, 2009.

B. State

1. Commonwealth of Virginia Emergency Services and Disaster Law of 2000, as amended.

2. Code of Virginia, Title 10.1, Chapter 6, Article 1.1, Section 10.1-603.1 through 10.1-603.8: Flood Prevention and Protection Assistance Fund.

3. Code of Virginia, Title 10.1, Chapter 6, Article 6, Sections 10.1-658 and 10.1-659.

4. Commonwealth of Virginia Emergency Operations Plan, Basic Plan, as amended.

5. Commonwealth of Virginia Hazard Mitigation Plan, March 2013

6. Virginia Department of Emergency Management website, Disaster Recovery, Hazard Mitigation located at: http://www.vaemergency.gov/emergency-management-community/grants/hmpg-2016/

DEFINITIONS

Applicant – A state agency, local government, or eligible private nonprofit organization, Indian tribes, or authorized tribal organizations submitting an application to the GAR for assistance under the Hazard Mitigation Grant Program. An applicant becomes a sub-recipient upon receipt of financial assistance.

Application – Refers to the initial request for Section 404 funding, as outlined in Section 206.436 of Federal 404 Regulations.

CFR – Code of Federal Regulations.

Declaration – An announcement of a Presidential determination that a natural catastrophe or other occasion or instance has occurred which requires federal assistance to supplement the Commonwealth and local efforts and resources to alleviate the damage, loss, hardship, or suffering caused thereby.

FEMA – Federal Emergency Management Agency.

FEMA-State Agreement – A formal legal document stating the understandings, commitments, and binding conditions for assistance applicable as the result of the major disaster or emergency declared by the President.

Governor's Authorized Representative (GAR) – The individual empowered by the Governor to represent him/her in activities related to the implementation of Public Law 93-288 and in ongoing state disaster/emergency preparedness, response, and hazard mitigation activities.

Grant – An award of financial assistance. The total amount eligible for the grant shall be based on 15 percent of the estimated total federal assistance provided under Sections 403, 406, 408, 410, 416, and 601 of the Stafford Act.

Recipient – The government to which a grant is awarded and which is accountable for use of the funds provided. The recipient is the entire legal entity even if only a particular component of the entity is designed in the grant award document. For purposes of this plan, the Commonwealth of Virginia is the recipient.

Hazard Mitigation - Any action taken to reduce or eliminate the long-term risk to life and property from natural or technological hazards. Any cost-effective measure that will reduce the potential for damage to a facility form a disaster event.

Hazard Mitigation Grant Program (HMGP) – The program authorized under Section 404 of the Act which may provide funding for certain mitigation measures identified through the evaluation of hazards conducted under Section 322 of the Act.

Hazard Mitigation Plan – The results of a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards present in society including the actions needed to minimize future vulnerability to hazards, as required under Section 322 of the Act.

Hazard Mitigation Plan Update – An update to the existing hazard mitigation plan, which may be accomplished either by updating the status of mitigation actions with the existing plan, or by expanding the existing plan to address additional hazards or mitigation issues.

Measure – A term used interchangeably with the term "project" to identify any mitigation action taken or proposed to reduce risk of future damage, hardship, loss, or suffering resulting from disasters.

Major Disaster – Any natural catastrophe, including any hurricane, tornado, storm, flood, high-water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, drought, fire, explosion, which, in the determination of the President of the United States is, or thereafter determined to be, of sufficient severity and magnitude to warrant major disaster assistance under the Stafford Act (P.L. 93-288 as amended by P. L. 100-707) to supplement the efforts and available resources of states, local governments, and disaster relief organizations in alleviating the damage, loss, hardship or suffering caused thereby and is so declared by the President.

Mitigation Strategy – A document developed immediately after the disaster declaration by the State Hazard Mitigation Officer, in consultation with the State Coordinating Officer that identifies mitigation priorities for the 404 Hazard Mitigation Grant Program and for other hazard mitigation activities implemented in the declared area(s).

National Flood Insurance Program (NFIP) - The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the Federal Government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available within the community as a financial protection against flood losses. This insurance is designed to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods.

Natural Disaster – Any non-man made catastrophe, including hurricane, tornado, storm high water, wind driven, tidal wave, tsunami, seiche, earthquake, volcanic eruption, landslide, mudslide, snowstorm, fire, or drought.

Pre-application Form – A standard form which provides basic details about the applicant, description of the project and estimated cost. The form is used to initially screen the potential projects for eligibility for the Hazard Mitigation Grant Program.

Private, Nonprofit Organization – Any nongovernmental agency or entity that currently has

a. An effective ruling letter from the U.S. Internal Revenue Service granting tax exemption under Section 501(c), (d), or (e) of the Internal Revenue Code of 1954 or
b. Satisfactory evidence from the state that the organization or entity is a nonprofit one organized or doing business under state law.

Project – Used interchangeably with the term "measure."

Regional Administrator – The administrator of the regional office (Region III) of FEMA, or his/her designated representative.

Section 322 Hazard Mitigation Plan – The State Hazard Mitigation Plan that is required as a condition of receiving federal disaster assistance under Section 322 of Public Law 93-288, as amended. The Section 322 Plan is the basis for the identification of measures to be funded under Section 404. The State Hazard Mitigation Plan is also an annex of the State Emergency Operations Plan and is promulgated to all state agencies and local governments.

Section 322 Projects – Projects proposed by eligible applicants through the State Hazard Mitigation Officer and Team to FEMA for implementation following a Presidential Disaster Declaration.

Standards – Codes or considerations required for the construction or modification of facilities, to include legal requirements for additional features. Such standards may be different for new construction, repair, or maintenance.

State Administrative Plan for the Hazard Mitigation Grant Program – This plan, developed by the state, which describes the procedures for administration of the Hazard Mitigation Grant Program.

State Hazard Mitigation Officer (SHMO) – The individual designated by the GAR as the responsible individual on all matters related to the Section 404 Hazard Mitigation Grant Program, the Section 322 Hazard Mitigation Planning Program, and the coordinated State Hazard Mitigation Planning Program.

State Hazard Mitigation Plan – As an annex to the State Emergency Operations Plan, the hazard mitigation plan is used as a means of identifying natural and assessing risks across the state. It is also the means of identifying and assessing hazard mitigation opportunities that will reduce the threat to people and property. Following Presidentially declared disasters; this plan will coincide with the Section 322 Plan and fall under its authorities and responsibilities.

State Hazard Mitigation Program – An ongoing program involving a coordinated effort of most state agencies to reduce the risks to people and property from natural hazards. During and following periods of Presidentially-declared disasters, this program will coincide with activities required under Sections 404 and 322 of Public Law 93-288 and the associated FEMA federal regulations. Further, this program will comply with the strategies and objectives specified in the State Hazard Mitigation Plan.

State Hazard Mitigation Committee – A group of individuals appointed by the directors of state agencies with hazard mitigation responsibilities or programs who will assist with hazard mitigation activities related to Sections 404 and 322 of Public Law 93-288 and to other ongoing activities of the state Hazard Mitigation Program.

Sub-grant – An award of financial assistance under a grant by the Recipient to an eligible Sub-recipient. The Sub-grant is a cost-share award providing 75 percent of the estimated costs of a hazard mitigation project from federal sources. The state, the local government, the Sub-recipient, or other source may provide the 25 percent nonfederal share.

Sub-recipient – The government or other legal entity to which a Sub-grant is awarded and which is accountable to the Recipient for the use of the funds provided. Sub-recipients can be a state agency, a local

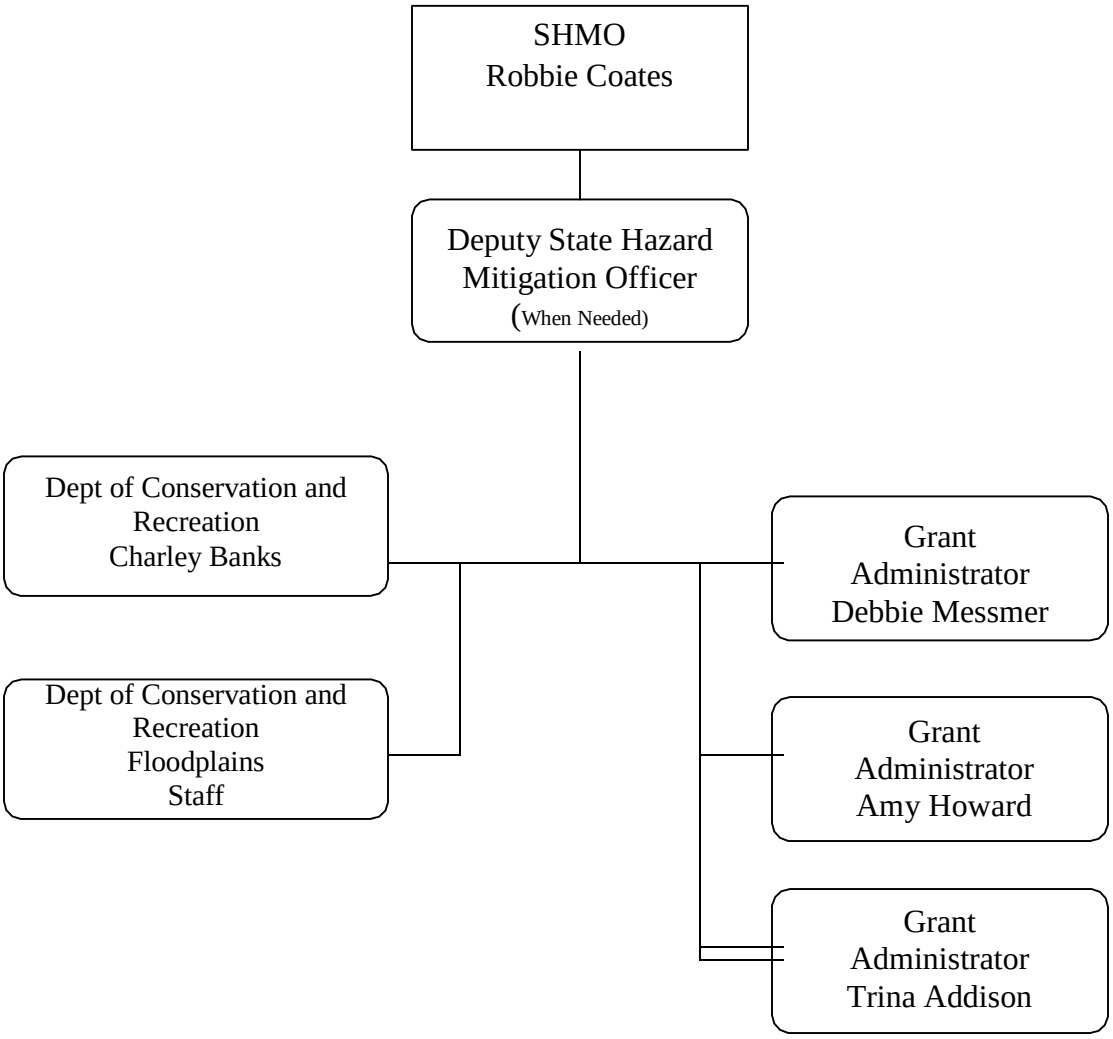
unit of government, a private nonprofit organization that provides essential government services, or Indian tribe as outlined in Section 206.433 of Section 404 Federal Regulations.

Supplement – The request that the state submits to FEMA to add or modify measure(s) for which Section 404 funding is requested, as outlined in Section 206.436. The application plus all supplements identify the total number of measures for which funding is requested.

VDEM – Virginia Department of Emergency Management.

Virginia Uniform Statewide Building Code - The Virginia Uniform Statewide Building Code (USBC) contains the building regulations that must be complied with when constructing a new building or structure or an addition to an existing building, maintaining or repairing an existing building, or renovating or changing the use of a building or structure.

***44 CFR 206.437 (b)(2) & (3)*HAZARD MITIGATION FLOW CHART FOR JFO**



Appendix I:

FEMA Approval Letter

U.S. Department of Homeland Security
Region III
One Independence Mall, 6th Floor
615 Chestnut Street
Philadelphia, PA 19106-4404

FEMA

March 12, 2018

Jeffrey D. Stern, Ph.D.
State Coordinator/Governor's Authorized Representative
Virginia Department of Emergency Management
10501 Trade Court
North Chesterfield, Virginia 23236-3713

Re: Commonwealth of Virginia State Hazard Mitigation Plan Approval

Dear Dr. Stern:

The U.S. Department of Homeland Security, the Federal Emergency Management Agency (FEMA) Region III Mitigation Division, Risk Analysis Branch has approved the updated Commonwealth of Virginia State Hazard Mitigation Plan effective, March 12, 2018 through March 11, 2023, in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR), §201.

A FEMA-approved state mitigation plan is a condition of receiving certain non-emergency Stafford Act assistance and FEMA mitigation grants from the following programs:

- Public Assistance Categories C-G (PA C-G)
- Fire Management Assistance Grants (FMAG)
- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)

State mitigation plans must be updated and resubmitted to the FEMA Region III Mitigation Division, Risk Analysis Branch for approval. If the plan is not updated by the expiration date indicated on this FEMA approval letter, the plan is considered lapsed and FEMA will not obligate funds until the mitigation plan is approved by FEMA.

If at any time over the plan approval period FEMA determines that the commonwealth is not complying with all applicable federal statutes and regulations in effect, with respect to the periods for which it receives funding or is unable to fulfill mitigation commitments, FEMA may take action to correct the noncompliance (44 CFR §§201.3(b)(5) and 201.4(c)(7)).

The commonwealth is responsible for communicating with local and tribal officials, as applicable, interested in applying through the commonwealth for FEMA assistance. FEMA encourages states to communicate with the appropriate officials regarding mitigation plan status and eligibility requirements. At a minimum of every six (6) months, FEMA will provide to the commonwealth written information on mitigation plans, including but not limited to:

- Local and tribal, as applicable, mitigation plan expiration dates
- Consequences of not having a FEMA-approved local or tribal, as applicable, mitigation plan with respect to eligibility for HMA programs;
- Availability of mitigation planning training and technical assistance; and
- Upcoming funding opportunities.

The commonwealth is responsible for reviewing and submitting approvable mitigation plans to FEMA. If the commonwealth is not submitting approvable mitigation plans, FEMA will provide feedback as well as technical assistance or training, as needed.

In addition, FEMA will provide a reminder to the commonwealth, at a minimum, twelve (12) months prior to the plan expiration date, of the consequences of not having a FEMA-approved mitigation plan with respect to eligibility for the FEMA assistance programs that require FEMA-approved mitigation plan as a condition of eligibility. To maintain eligibility for PA C-G, FMAG, HMGP, PDM and FMA, the commonwealth must submit a draft of the next plan update prior to the end of the approval period, and allow sufficient time for the review and approval process, including any revisions, if needed, and for formal adoption by the state following determination by FEMA that the plan has achieved a status of "Approvable Pending Adoption".

Finally, we look forward to working with you to discuss the status of Virginia's mitigation program each year over the approval period.

If we can be of assistance, please contact Janice Barlow, Director, Mitigation Division, at (215) 931-5669 or janice.barlow@fema.dhs.gov.

Sincerely,

MaryAnn Tierney
Regional Administrator

cc: Donna Pletch, Chief, Strategic Planning Branch
Robbie Coates, State Hazard Mitigation Officer
Susan Mongold, Deputy Coordinator for Mission Support

Appendix J:

State Adoption

JEFFREY D. STERN, Ph.D.
State Coordinator

SUSAN L. MONGOLD
Deputy Coordinator – Mission Support

JOHN SCRIVANI
Deputy Coordinator – Disaster Services

COMMONWEALTH of VIRGINIA

Department of Emergency Management
10501 Trade Court
North Chesterfield, Virginia 23236-3713
Tel: (804) 897-6500 TDD (804) 674-2417 FAX (804) 897-6506

March 7, 2018

To: Dr. Jeffrey Stern, State Coordinator

From: Donna Pletch, Strategic Planning Branch Chief DMP
Robbie Coates, State Hazard Mitigation Officer

Through: Bill Mahoney, Planning Division Director
John Scrivani, Deputy Coordinator for Disaster Services
Susan Mongold, Deputy Coordinator for Mission Support

In accordance with the Executive and Policy guidance provided, and in accordance with §44.146.18 of the *Code of Virginia*, which requires the Virginia Department of Emergency Management to "Promulgate plans and programs that are conducive to adequate disaster mitigation, preparedness, response, and recovery programs" we submit and request your review, approval, adoption, and implementation of the 2018 Commonwealth of Virginia Hazard Mitigation Plan.

DMP

Approved and Adopted:

Jeffrey D. Stern

Date 3/12/18

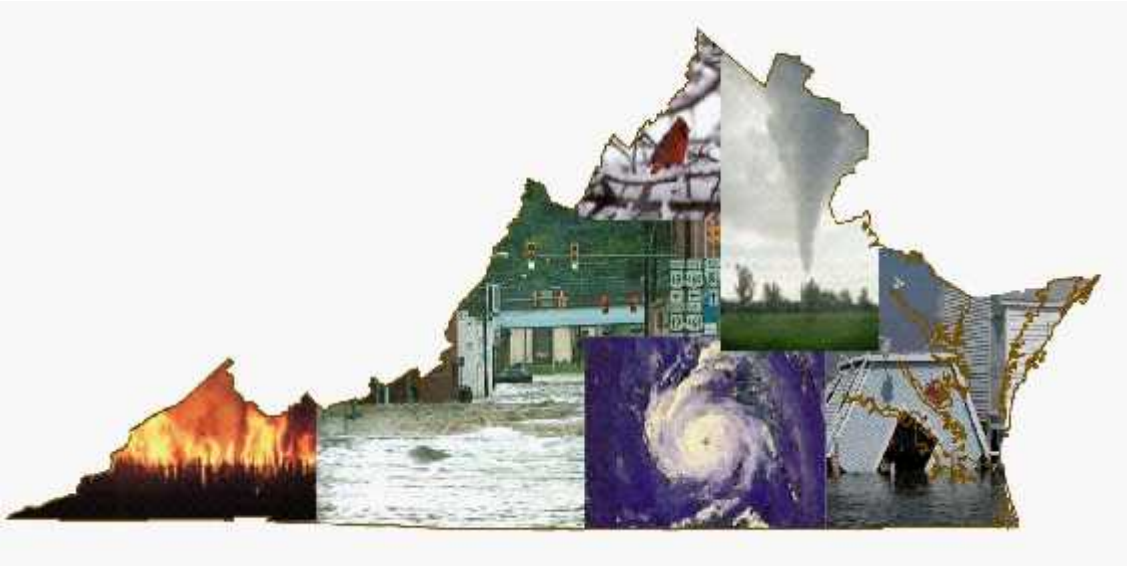
Appendix K:

Threats

This Section Has Been Redacted

This section contains sensitive and confidential information that is not subject to FOIA under *Code of Virginia* §2.2-3705.2.

Loss Avoidance Study for the Commonwealth of Virginia's 2018 Update to the State Hazard Mitigation Plan



March 2018

Developed and published by the Virginia Department of Emergency Management and Witt O'Brien's.

Appendix L:

Loss Avoidance Study

A. Introduction

The Commonwealth of Virginia has a history and exposure to a wide array of natural hazards – from wind to earthquakes to wildfires to flooding. Because of this exposure and risk, the Commonwealth has a long-established commitment to hazard mitigation, specifically to encouraging, promoting, assisting with, and funding actions and projects to reduce or eliminate long-term risks to people and property from natural hazards and their effects.

Through the Virginia Department of Emergency Management (VDEM), and in conjunction with a number of federal agencies (including FEMA), the Commonwealth has made project and planning dollars available to Virginia communities to implement hazard mitigation measures. Since 1989, more than $122 million in hazard mitigation funding has been awarded to Virginia communities and agencies, for a range of mitigation activities and projects[1].

To document and examine the impact that this mitigation funding has had in Virginia requires an examination of completed mitigation projects. As part of the 2018 update to the *Commonwealth of Virginia Hazard Mitigation Plan,* VDEM determined that it is appropriate to examine a selection of completed mitigation projects and determine the real-world losses avoided through those projects. This study is the final product of that process.

A review of completed mitigation projects in Virginia determined two areas of the state that were especially ideal for this study – the City of Poquoson and the City of Roanoke. The City of Poquoson has a long history of coastal flooding, and has completed more than a hundred private property mitigation projects because of that flood history. The City of Roanoke has an extensive history of riverine flooding, and completed several private property acquisitions, in addition to an extensive greenway and several other drainage and flood control projects. The mitigation projects these two communities completed were also far enough back in time that they allowed for other flood events to have occurred in the project areas. This is necessary for a study such as this one, to determine what losses would have occurred from those events if those structures had remained unmitigated when the later flood occurred.

A discussion of the location and property selection process follows later in this study.

B. Flooding History

Flooding is one of the most common and frequent hazards in both the US and in the Commonwealth of Virginia. Between 1957 and 2016, there were 38 federal disaster declarations in Virginia that involved flooding – this equates to almost 60% of the federal disaster declarations during that time frame. Hundreds of other, smaller floods have impacted communities in the Commonwealth during that same period. Virginia experiences both coastal and riverine flooding, depending on the location within the Commonwealth. Virginia's most urbanized areas lay within broad, flat coastal plains, prone to both coastal and riverine flooding. In the mountainous western portion of the Commonwealth, most urban development lays along relatively flat river valleys, which experience both riverine and flash flooding.

1. B.1 City of Poquoson

Located on the lower Chesapeake Bay, Poquoson occupies 15 miles² of land and 63 miles² of water. The entire eastern side of the City is home to the Plum Island National Wildlife Refuge, which – together with privately owned salt marsh lands – makes up the largest saline marsh in the lower Chesapeake Bay[2]. Most of the City has an elevation of no more than seven feet above mean sea level, making it vulnerable to all types of coastal flooding, including tropical storms, hurricanes, nor'easters, and tidal flooding. Most flooding in Poquoson does not occur because of hurricanes, but rather because of unnamed low-pressure systems[3].

Because of this history and geography, Poquoson is committed to hazard mitigation. In the last two decades, they have sought and received funding through VDEM for more than 60 private property elevation projects, to help their residents protect their property from flooding. After Hurricane Isabel in 2003, the City sought and received funding for more than 30 elevation projects. As more than ten years have passed since these structures were elevated, this study focused on elevations that were completed after Isabel (2003).

A review of the City's hazard mitigation plan found dozens of documented occurrences of flooding – rainfall, high tides, storms, etc. Because of the extensive and well-documented history, this study will focus on two recent events – Hurricane Irene, which passed by Poquoson as a Category 1 hurricane in August of 2011, and 'Nor'Ida', a mid-Atlantic nor'easter that impacted the City in November 2009.

Details of the specific structures studied and the selection process follows later in this study.

2. B.2 City of Roanoke

Situated on the eastern border of the Appalachian Plateau and the western slope of the Blue Ridge Mountains, the City of Roanoke is the largest and most populous city in an otherwise mostly rural area. The watersheds in the region around the City are typical of the area, with smaller streams collecting water flowing through steep terrain, picking up in velocity, and flowing into the valleys and flatlands along major rivers, including the Roanoke River, which runs through the City. The most severe flooding on the Roanoke River usually results from heavy rains associated with tropical storms, while tributary stream flooding usually happens following localized thunderstorms or stalled frontal systems. Flooding along the tributaries is compounded when waterways at lower elevations backup into feeder streams[4].

Most of the severe flooding in the City occurs along the 13 major creeks and rivers in the area: Barnhardt (or Cravens) Creek, Garnand Branch, Glade Creek, Gum Spring, Lick Run, Mudlick Creek, Murdock Creek, Murray Run, Ore Branch, Peters Creek, Roanoke River, Tinker Creek, and Trout Run. In November 1985, the City experiencing the worst flood of record on the Roanoke River and many of its tributaries. In September 2004, a significant flood event caused more than $14 million in property damage in the Roanoke Valley[5].

The City of Roanoke is home to part of the Roanoke Valley Greenways. These areas of intentionally undeveloped (or formerly developed) land began with a project to replace the City's sewer lines in 1993. In 1995, at the urging of residents, four local governments – including the City of Roanoke – established a Greenways/Open Space Steering Committee, and began to seriously study other communities with similar issues and concerns. The outcome was the decision to create a greenway plan and to hire a Greenway Coordinator through the Roanoke Valley-Alleghany Regional Commission, to facilitate the planning and development process. The Conceptual Greenway Plan was completed in late 1995, and in early 1996 the Steering Committee began a pilot project. Since then, work has been continuous on the creation of Greenway space in the area, including the City[6].

While the Greenway is not solely a flood mitigation project, is has reduced flooding in the region and the City. By creating open space for water to pass over with no obstructions and no property to damage, Roanoke has seen less severe floods and experienced less property damage as a result. In addition, the City has completed two significant flood reduction projects in the previous thirty years – the Peters Creek Flood Reduction Project and the Roanoke River Flood Reduction Project.

The Peters Creek Project was completed by the City in three phases. The first phase, completed in 1991, consisted of five culvert upgrades and stream channelization, which was performed by removing earthen fill material along the Peters Creek tributary for approximately ¾ mile. The second phased (1993) involved clearing vegetative debris along the tributary. The final phase (2000) included construction of two regional stormwater management detention facilities, located near the top of the Peters Creek watershed, to provide controlled releases during storm events[7].

The Roanoke River Project was implemented in partnership with the US Army Corps of Engineers – Wilmington District (USACE), as part of the Energy and Water Development Appropriations Act of 1990. The project included approximately 6.2 miles of channel widening along the 10-mile reach. Channel widening was accomplished through the construction of a benched channel above the elevation of the average stream flow. Other project activities included flood proofing a hospital and the waste water treatment plant, two training walls to prevent floodwater intrusion into low-lying areas along the river, and the installation of a flood warning system (IFLOWS). Additionally, the project, which was implemented between 2004 and 2012, created a 7-mile stretch of greenway trail along the project reach.

In addition, the City has worked with VDEM to obtain hazard mitigation grant funding to acquire flood damaged residential structures in the City, largely in the Garden City area. Since 1996, the City has received funds to acquire 15 residential structures and to covert the lots to permanent green space, thereby permanently removing the threat of future flood damages to the structures on those lots.

Details of the specific structures studied and the selection process follows later in this study.

C. Project Methodology

A loss avoidance study (LAS) provides a justification for existing and future mitigation projects and activities. The ability to assess the economic performance of mitigation projects over time is important to encourage future funding and continued support of mitigation projects, activities, and programs. An LAS requires that the projects studied be completed prior to the event(s) analyzed, as losses avoided though the mitigation measure are determined by comparing the damage that would have been caused by the event, had the projects not be implemented.

This LAS looked at previously completed private property mitigation activities in two areas of the Commonwealth – the Cities of Poquoson and Roanoke – and determined the damages the properties would have sustained had they not been acquired or elevated. As the two areas of study implemented different mitigation measures, the specific methodology used for each area is discussed below.

An array of data points was collected to determine the effectiveness of the mitigation projects completed in both study areas. These data points included:

- Original finished floor elevations (pre-mitigation)
- Post-mitigation finished flood elevations
- Base Flood Elevations

- Square footage of the structures
- Structure type
- Cost of the mitigation measure
- Value of the structure
- Value of the structure's contents
- Depth of flooding in project area (post-mitigation)

For both study areas selected, a review of the mitigated properties was conducted. The review included grant documents provided by VDEM, NFIP claims data for the community, and flood history data from both the community and the National Weather Service. After review of this data, specific properties were identified within each study area. The identified properties were found to have the most complete data sets of all properties reviewed.

Figure 1: Loss Avoidance Study Process



3. C.1 City of Poquoson

The structures studied in Poquoson were all elevated to a minimum of one foot above the applicable base flood elevation (BFE) at the time the project was completed[1]. The selected properties were all elevated after Hurricane Isabel (2003), and are in areas of the City that continue to experience flooding to the present day. The LAS team used a depth-damage calculation that determined the dollar value of losses avoided, based on the likely depth of inundation the structure would have received prior to mitigation. This calculation was then compared to the project cost to elevate the structure to determine the cost-effectiveness of the mitigation. These depth-damage calculations appear in the following tables.

Table 1: Residential Building Depth-Damage Calculations (Generic)[8]

Building Type	One Story (no basement)	Two story (no basement)
Flood Depth (in feet)	Percent Damaged	Percent Damaged
-1.5 to -0.5	2.5%	3%
-0.5 to 0.5	13.4%	9.3%
0.5 to 1.5	23.3%	15.2%
1.5 to 2.5	32.1%	20.9%
2.5 to 3.5	40.1%	31.4%
3.5 to 4.5	47.1%	31.4%
4.5 to 5.5	53.2%	36.2%

Table 2: Residential Building Contents Depth-Damage Calculations (Generic)[9]

Building Type	One Story (no basement)	Two story (no basement)

[1] As of December 2014, Poquoson's ordinance now requires a minimum of three feet of freeboard.

Flood Depth (in feet)	Percent Damaged	Percent Damaged
-1.5 to -0.5	2.4%	1%
-0.5 to 0.5	8.1%	5%
0.5 to 1.5	13.3%	8.7%
1.5 to 2.5	17.9%	12.2%
2.5 to 3.5	22%	15.5%
3.5 to 4.5	25.7%	18.5%
4.5 to 5.5	28.8%	21.3%

4. C.2 City of Roanoke

The subject structures in the City of Roanoke were all acquired and demolished, with the remaining land being converted to greenspace in perpetuity. The majority of the structures (11) were acquired in approximately 1996, with a handful (four) acquired approximately ten years later, in approximately 2005.

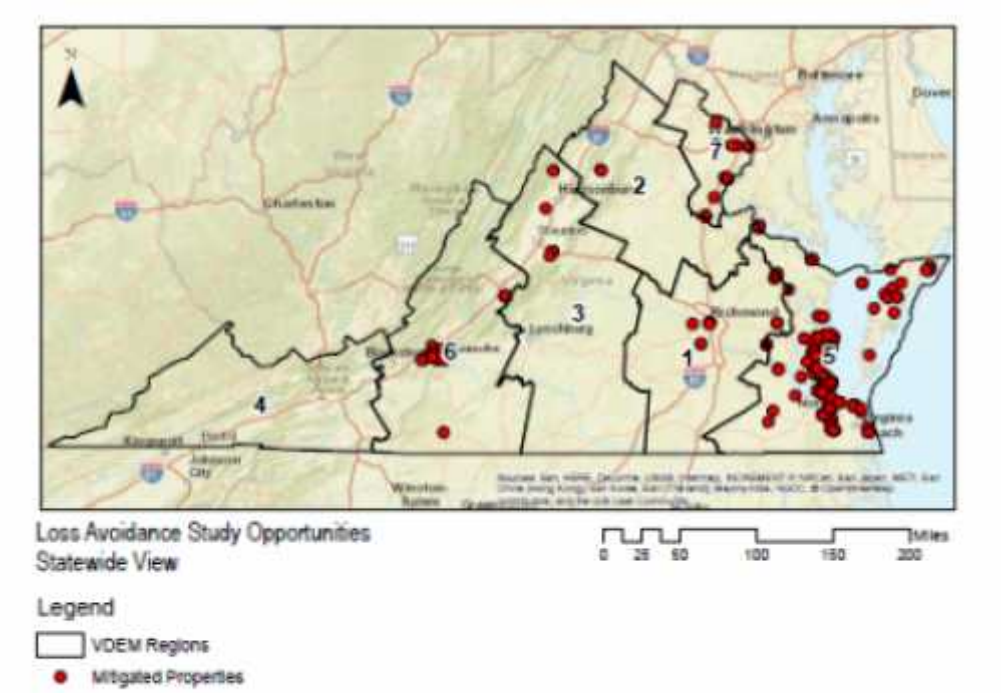
In the approximately two decades since the original structures were acquired, the City has undertaken the previously discussed array of other flood mitigation measures – namely, the creation of the greenway, the Peters Creek project, and the Roanoke River project. Each of these projects were implemented or completed during the same timeframe as the study period of the mitigated structures.

While there has been flooding in the City since these structures were acquired, there has been little flooding in the areas where the subject structures were previously located. This is likely due to a combination of factors – most notably the other mitigation activities in the watersheds – and not due to a natural decrease in flooding, as a review of rainfall data in the City does not indicate a decrease in rainfall during the study period.

D. Project & Property Selection

Using completed mitigation project data, the LAS team mapped each mitigated private property structure in the Commonwealth, focusing on those that were either elevated or acquired. No other mitigation types were considered for this effort. The overall results of this initial effort appear in the figure following.

Figure 2: LAS Opportunities - Statewide View



Once the structures were mapped, the maps were examined to determine clusters of structures in various areas of the Commonwealth – similar topography, similar or same source of flooding, similar timeframe for implementation of the mitigation measure. The following communities were initially considered for this study:

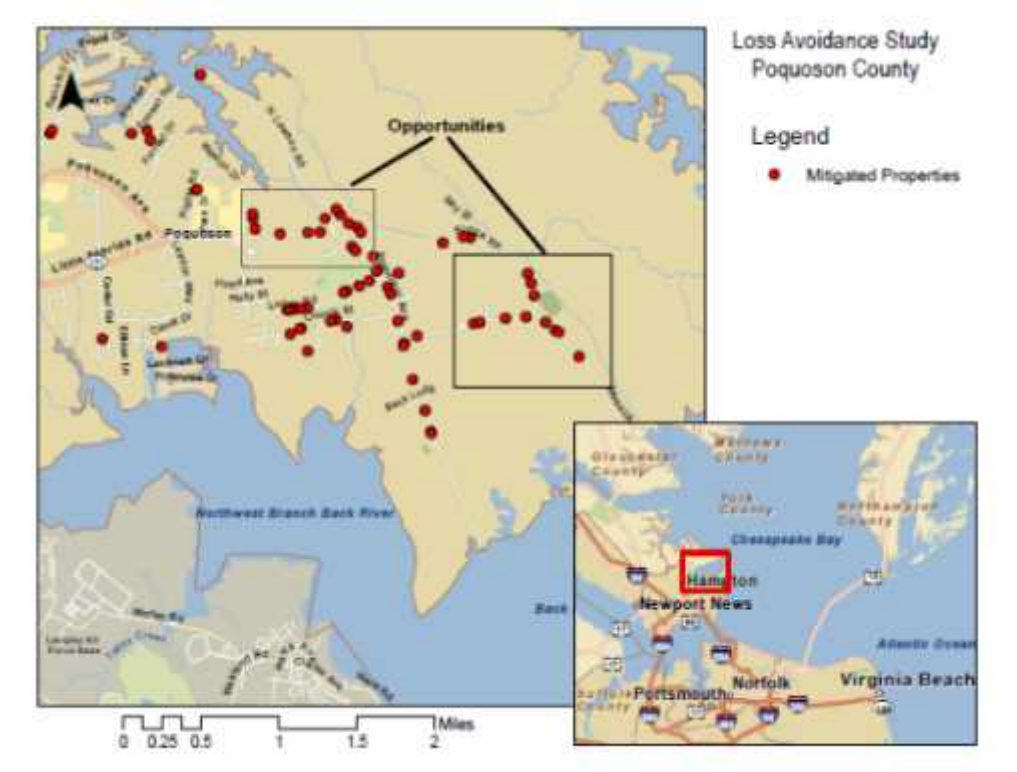
1. Chesapeake County
2. Gloucester County
3. Hampton County
4. Northumberland County
5. Prince William County
6. Virginia Beach County
7. City of Newport News
8. City of Norfolk
9. City of Poquoson
10. City of Roanoke
11. City of Tangier Island

Discussed with the LAS team and VDEM staff determined that the best candidates for this effort were likely the City of Poquoson and the City of Roanoke. It was important to all that both a riverine flood area and a coastal flood area be included, and that both elevations and acquisitions be included, if possible, and it was determined that these communities best fit the established criteria.

5. D.1 City of Poquoson

Once selected, it was necessary to further refine the properties for inclusion in the study. It was determined that two areas of the City had the strongest potential to yield results, based on location, topography, and project completion date.

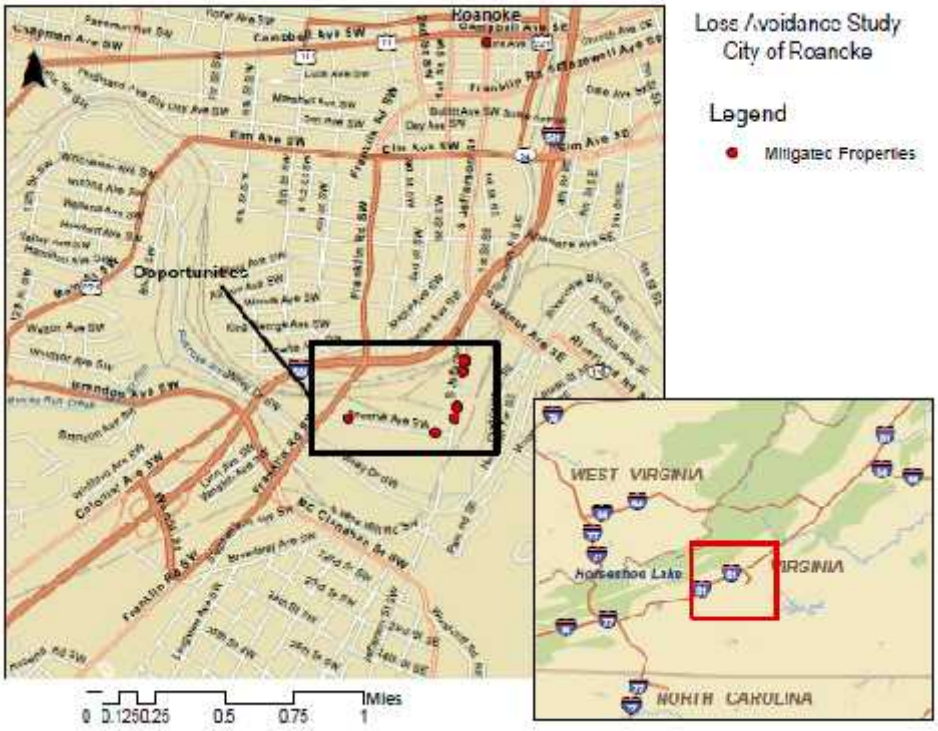
Figure 3: LAS Opportunities - City of Poquoson



6. D.2 City of Roanoke

A similar process was followed for property selection in the City of Roanoke. It was important that the study properties be in approximate relation to one another in terms of topography and flood history, and that the projects were completed early enough to allow time for post-mitigation flood events to occur.

Figure 4: LAS Opportunities - City of Roanoke



E. Losses Avoided

To complete this study, the following calculations were performed:

- Losses to the community from the subject storm events
- Storm surge elevations
- Historic crest elevations
- Residential building depth-damage
- Residential building contents depth-damage
- Losses avoided through mitigation

7. E.1 City of Poquoson

The week of September 25, 2017, a site visit was made to Poquoson. The purpose was to meet and interview local and state officials and view the mitigated structures. The City of Poquoson provided documentation and anecdotal information regarding two coastal flood events in 2009 (Nor'Ida) and 2011 (Hurricane Irene), as well as a wealth of other local information. During the site visits GPS and address information was confirmed, and photographs of the current condition of the mitigated structures were taken. Based on the interviews and documentation, the 2009 and the 2011 coastal flood events were used to measure cost effectiveness.

1. E.1.1 Storm History Calculations

The following calculations were made and used for the 2009 and 2011 storm events in Poquoson.

DR-1862 Tropical Depression (Nor' Ida)
Declaration Date: 12/09/2009
Incident Period: 11/11/2009 through 11/16/2009

Table 3: Nor'Ida Damage Estimates (from PDA)[10]

Type Property	Major Damage	Minor Damage	Dollar Loss
Single Dwelling	150	400	$6,950,000
Multi-Family		1	$20,000
Business Industry		5	$50,000
Non-Profit Buildings		2	$20,000
Total	**150**	**408**	**$7,040,000**

FEMA Public Assistance was estimated at an additional $412,514 (infrastructure damage and emergency protective measures). This brings the total storm preliminary damage estimate to **$7,452,514**.

Surge Elevation - NOAA Gage at James River (VA) Sewell's Point
7.74 feet on 11/12/2009 (3rd highest recorded elevation)

DR-4024 Hurricane Irene
Declaration Date: 09/03/2011
Incident Period: 08/26/2011 through 08/28/2011

Table 4: Hurricane Irene Damage Estimates (from PDA)[11]

Type Property	Major Damage	Minor Damage	Dollar Loss
Single Dwelling	42	40	$930,000
Multi-Family	0	0	0
Business Industry	0	0	0
Non-Profit Buildings	1	0	$50,000
Total	**43**	**40**	**$980,000**

FEMA Public Assistance was estimated at $ 170,393 (infrastructure damage and emergency protective measures). This brings the total storm preliminary damage estimate to **$1,150,393.**

Surge Elevation - NOAA Gage at James River (VA) Sewell's Point
7.55 feet on 08/27/2011 (4th highest recorded elevation)

Historic crest calculations for both the York and James Rivers can be found in the tables following.
Table 5: York River - Highest Historic Crests

York River – NOAA Gage Historic Crests[2]		
Ranking	**Elevation**	**Date**
1	7.61 feet	11/12/2009

[2] Gage since discontinued.

York River – NOAA Gage Historic Crests[2]		
Ranking	**Elevation**	**Date**
2	7.54 feet	09/18/2003
3	7.38 feet	08/27/2011
4	7.15 feet	10/28/2012
5	7.13 feet	10/29/2012

Table 6: James River - Highest Historic Crests

James River – NOAA Gage Historic Crests		
Ranking	**Elevation**	**Date**
1	8.02 feet	08/23/1933
2	7.89 feet	09/18/2003
3	7.74 feet	11/12/2009
4	7.55 feet	08/27/2011
5	7.22 feet	03/07/1962
6	6.81 feet	03/07/1962
7	6.72 feet	09/18/1936
8	6.63 feet	11/22/2006
9	6.58 feet	02/05/1998
10	6.52 feet	10/07/2006

2. E.1.2 Project Funding

On March 31, 2006, the City of Poquoson entered into an agreement with VDEM to receive DR-1491 HMGP funding. On April 24, 2006, the Poquoson City Council passed a resolution accepting an HMGP sub- grant for elevating fifteen residential structures. The project had an initial estimated budget of $655,650; this figure was revised in December 2007 to $830,650[12].

Note: Five of the original structures were not included in this review. One structure was not elevated; two structures no longer exist, and two structures were later replaced with new structures. Seven additional structures were moved to the CDBG program. These seven were included in this study, bringing the total number of structures in the study to 17.

3. E.1.3 Loss Avoidance Calculations

The surge elevation was obtained from the James River Gage for both the 2009 and 2011 coastal flood events. The finished floor elevations were subtracted from the James River Gage reading to arrive at the flood depth. The flood depth was used in the building and content depth damage function described below, and seen in Tables 1 and 2 (earlier in this document).

Residential Building Depth Damage – The USACE residential building depth damage function was used to calculate building damage. The residential building depth damage curve was used to assign the percent damaged based on depth of water and number of stories. The percent damage was multiplied by the value of the structure to arrive at a damage cost.

Residential Building Contents Depth Damage – The USACE residential building content depth damage function was used to calculate content damage. The residential building content depth damage curve was used to assign the percent damaged based on depth of water and number of stories. The percent damage was multiplied by the value of the structure to arrive at a damage cost.

Building and content depth damage calculations were made for the 2009 and 2011 coastal flood events. The sum of building and content damage for both flood events equals losses avoided.

The losses avoided divided by the project cost provides the ratio. The table on the following page provides the calculation details for each structure included in the final study.

Table 7: Losses Avoided - 2009 Storm Event

Property ID	Year Built	Number of Stories	Finished Floor Elevation (pre-mitigation)	Finished Floor Elevation (post-mitigation)	Cost of Mitigation	Structure Value	2009 Losses Avoided (Structure)	2009 Losses Avoided (Contents)	2009 Total Losses Avoided	2009 Benefit-Cost Ratio
7	1949	2	3.6 feet	10 feet	$31,850	$65,900	$20,693	$12,192	$32,885	1.03
31	1939	1	4.0 feet	11 feet	$28,150	$63,000	$29,673	$16,191	$45,864	1.63
12	1957	1	4.1 feet	11 feet	$44,350	$86,000	$40,506	$22,102	$62,608	1.41
18	1949	1	4.4 feet	11 feet	$28,150	$51,300	$20,571	$11,286	$31,857	1.13
10	1949	1	4.5 feet	11 feet	$44,350	$73,300	$29,393	$16,126	$45,519	1.03
6	1948	1	4.8 feet	10 feet	$43,150	$94,300	$37,814	$20,746	$58,560	1.36
4	1958	1	5.0 feet	10 feet	$43,150	$105,800	$42,426	$23,276	$65,702	1.52
2	1949	1	5.3 feet	10 feet	$43,250	$95,900	$30,784	$17,166	$47,950	1.11
9	1965	1	5.5 feet	10 feet	$49,350	$75,900	$24,364	$13,586	$37,950	0.77
11	1965	1	5.9 feet	10 feet	$43,150	$97,000	$31,137	$17,363	$48,500	1.12
5[3]	1949	2	4.6 feet	11 feet	$43,450	$113,500	$29,851	$17,593	$47,444	1.09
15	1949	2	5.0 feet	10 feet	$39,250	$99,100	$26,063	$17,361	$41,424	1.06
16	1949	2	5.0 feet	11 feet	$43,450	$97,600	$25,669	$15,128	$40,797	0.94
24	1955	1	5.0 feet	10 feet	$38,170	$101,800	$40,822	$22,396	$63,218	1.66
14	1949	2	5.3 feet	10 feet	$58,150	$78,000	$16,302	$9,516	$25,818	0.44
23	1949	1	5.5 feet	10 feet	$56,050	$106,500	$34,187	$19,064	$53,251	0.95
25	1970	1	5.8 feet	10 feet	$74,950	$185,700	$59,610	$33,240	$92,850	1.24
--	--	--	**4.9 feet (Average)**	**10.35 feet (Average)**	**$752,370 (Total)**	**$1,590,600 (Total)**	**$539,864 (Total)**	**$302,330 (Total)**	**$842,194 (Total)**	**1.12 (Aggregate)**

[3] Properties 5, 15, 16, 24, 14, 23, and 25 were funded using CDBG rather than HMGP funds.

Table 8: Losses Avoided - 2011 Storm Event

Property ID	Year Built	Number of Stories	Finished Floor Elevation (pre-mitigation)	Finished Floor Elevation (post-mitigation)	Cost of Mitigation	Structure Value	2011 Losses Avoided (Structure)	2011 Losses Avoided (Contents)	2011 Total Losses Avoided	2011 Benefit-Cost Ratio
7	1949	2	3.6 feet	10 feet	$31,850	$65,900	$20,693	$12,192	$32,884	1.03
31	1939	1	4.0 feet	11 feet	$28,150	$63,000	$29,673	$16,191	$45,864	1.63
12	1957	1	4.1 feet	11 feet	$44,350	$86,000	$34,486	$18,920	$53,406	1.20
18	1949	1	4.4 feet	11 feet	$28,150	$51,300	$20,571	$11,286	$31,857	1.13
10	1949	1	4.5 feet	11 feet	$44,350	$73,300	$29,393	$16,126	$45,519	1.03
6	1948	1	4.8 feet	10 feet	$43,150	$94,300	$37,814	$20,746	$58,560	1.36
4	1958	1	5.0 feet	10 feet	$43,150	$105,800	$42,426	$23,276	$65,702	1.52
2	1949	1	5.3 feet	10 feet	$43,250	$95,900	$30,784	$17,166	$47,950	1.11
9	1965	1	5.5 feet	10 feet	$49,350	$75,900	$24,364	$13,586	$37,950	0.77
11	1965	1	5.9 feet	10 feet	$43,150	$97,000	$31,137	$17,363	$48,500	1.12
5[4]	1949	2	4.6 feet	11 feet	$43,450	$113,500	$29,851	$17,593	$47,443	1.09
15	1949	2	5.0 feet	10 feet	$39,250	$99,100	$26,063	$15,361	$41,424	1.06
16	1949	2	5.0 feet	11 feet	$43,450	$97,600	$25,669	$15,128	$40,797	0.94
24	1955	1	5.0 feet	10 feet	$38,170	$101,800	$40,822	$22,396	$63,218	1.66
14	1949	2	5.3 feet	10 feet	$58,150	$78,000	$16,302	$9,516	$25,818	0.44
23	1949	1	5.5 feet	10 feet	$56,050	$106,500	$34,187	$19,064	$53,250	0.95
25	1970	1	5.8 feet	10 feet	$74,950	$185,700	$59,610	$33,240	$92,850	1.24
--	--	--	**4.9 feet (Average)**	**10.35 feet (Average)**	**$752,370 (Total)**	**$1,590,600 (Total)**	**$533,844 (Total)**	**$299,149 (Total)**	**$832,992 (Total)**	**1.11 (Aggregate)**

[4] Properties 5, 15, 16, 24, 14, 23, and 25 were funded using CDBG rather than HMGP funds.

Table 9: Losses Avoided - Aggregate of Both Storm Events

Property ID	Year Built	Number of Stories	Finished Floor Elevation (pre-mitigation)	Finished Floor Elevation (post-mitigation)	Cost of Mitigation	Structure Value	2009 Losses Avoided (Total)	2011 Losses Avoided (Total)	Aggregate Losses Avoided	Aggregate Benefit-Cost Ratio
7	1949	2	3.6 feet	10 feet	$31,850	$65,900	$32,885	$32,884	$65,768	2.06
31	1939	1	4.0 feet	11 feet	$28,150	$63,000	$45,864	$45,864	$91,728	3.23
12	1957	1	4.1 feet	11 feet	$44,350	$86,000	$62,608	$53,406	$116,014	2.61
18	1949	1	4.4 feet	11 feet	$28,150	$51,300	$31,857	$31,857	$63,715	2.26
10	1949	1	4.5 feet	11 feet	$44,350	$73,300	$45,519	$45,519	$91,039	2.05
6	1948	1	4.8 feet	10 feet	$43,150	$94,300	$58,560	$58,560	$117,121	2.71
4	1958	1	5.0 feet	10 feet	$43,150	$105,800	$65,702	$65,702	$131,404	3.04
2	1949	1	5.3 feet	10 feet	$43,250	$95,900	$47,950	$47,950	$95,900	2.21
9	1965	1	5.5 feet	10 feet	$49,350	$75,900	$37,950	$37,950	$75,900	1.53
11	1965	1	5.9 feet	10 feet	$43, 150	$97,000	$48,500	$48,500	$97,000	2.23
5[13]	1949	2	4.6 feet	11 feet	$43,450	$113,500	$47,444	$47,443	$94,886	2.18
15	1949	2	5.0 feet	10 feet	$39,250	$99,100	$41,424	$41,424	$82,848	2.11
16	1949	2	5.0 feet	11 feet	$43,450	$97,600	$40,797	$40,797	$81,594	1.87
24	1955	1	5.0 feet	10 feet	$38,170	$101,800	$63,218	$63,218	$126,436	3.31
14	1949	2	5.3 feet	10 feet	$58,150	$78,000	$25,818	$25,818	$51,636	088
23	1949	1	5.5 feet	10 feet	$56,050	$106,500	$53,251	$53,250	$106,500	1.90
25	1970	1	5.8 feet	10 feet	$74,950	$185,700	$92,850	$92,850	$185,700	2.47
--	--	--	**4.9 feet (Average)**	**10.35 feet (Average)**	**$752,370 (Total)**	**$1,590,600 (Total)**	**$842,194 (Total)**	**$832,992 (Total)**	**$1,675,186 (Total)**	**2.22 (Aggregate)**

As is clear from the preceding tables, the private property elevation projects implemented in the City of Poquoson were cost-beneficial. While not every structure has delivered a positive return on the initial investment to date, the project has resulted in at least $2.22 in avoided losses for every dollar spent on mitigation. This positive return on taxpayer investment demonstrates that VDEM, the City of Poquoson, and the Commonwealth as whole have a sound understanding of where and how to fund and implement effective mitigation projects to prevent or reduce future damages and losses.

8. E.2 City of Roanoke

The week of September 04, 2017, a site visit was made to Roanoke. The purpose was to meet and interview local and state officials and view the mitigated properties. During the site visits GPS and address information was confirmed, and photographs of the current condition of the mitigated properties were taken. The City of Roanoke provided documentation and anecdotal information regarding other flood control and mitigation measures enacted in the City over the previous two decades, as well as a wealth of other local information and insight. City staff confirmed that – while there have been floods in the City since these properties were acquired – no flooding has occurred in the project areas since the properties were acquired. A review of the available, documented flood history of the City confirmed this finding.

1. E.2.1 Project Funding

The mitigation projects funded in the City of Roanoke were all implemented as private property acquisition projects, in which the existing structures were demolished and the remaining lots were deed-restricted to greenspace in perpetuity. Fifteen properties were identified to study. Twelve of these properties were funded through HMGP (using DR-1021 (1998) and DR-1570 (2005) funds), with the remaining three funded through FMA FY05.

In the original project applications for HMGP, ten of the eleven properties were excluded from the general requirement to demonstrate that the project was cost-beneficial. This is because of a FEMA policy which waived the normally required benefit-cost analysis if the property to be acquired meets two conditions:

- The property is located within a FEMA-identified Special Flood Hazard Area (SFHA), also known as the 100-year or 1% annual chance floodplain, but is not located in a coastal high hazard area (i.e., a V-zone); and
- The property has been declared to be substantially damaged by the local authority, meaning that the damage to the property (from any source) is greater than 50% of the value of the structure at the time the damage occurred.

Each of these ten properties met these two conditions at the time of acquisition, and so were assumed to be cost-effective. Therefore, no benefit-cost analysis was performed as part of the application process.

For the remaining property acquired through HMGP funds, a benefit-cost analysis was performed as part of the application. Records provided by VDEM indicate that the benefit-cost ratio for this property was 1.0, meaning that for every $1 spent to acquire and demolish the structure, $1 in damages was assumed to be avoided.

For the three properties acquired using FMA funds, a benefit-cost analysis was performed as part of the application process. These properties had individual benefit-cost ratios of 1.22, 1.69, and 0.56 to 1, for an overall project benefit-cost ratio of 1.15 to 1. This means that for every $1 spent to acquire and demolish these properties, $1.15 in damages was assumed to be avoided[14].

2. E.2.2 Losses Avoided

As there have been no documented flood events in the study area since the properties were acquired and the land returned to greenspace, actual losses avoided cannot be calculated, as there are no post-mitigation damages in the project area to use in the calculation.

Based on the interviews and documentation, it is assumed that these other mitigation and flood control measures (discussed earlier in this document) are a significant reason for the lack of flood occurrences since mitigation, though this cannot be confirmed without a detailed hydrology and hydrological study (H&H), which is outside of the scope of this study.

2. Appendix

An extensive, multi-tab spreadsheet accompanies this study. This spreadsheet contains all data and calculations used to produce this study, for both the City of Poquoson and the City of Roanoke. Due to the amount of data contained in this spreadsheet, it is not practical to import it into this document. Thus, it is submitted as an appendix to this study.

Endnotes

[1] VDEM Hazard Mitigation Project Reports, Open and Closed projects. 2017.
[2] Hampton Roads Hazard Mitigation Plan. 2017.
[3] City of Poquoson website. http://www.ci.poquoson.va.us/264/Flood-Information. 2017.
[4] Roanoke Valley-Alleghany Regional Commission Regional Pre-Disaster Mitigation Plan. 2013.
[5] City of Roanoke. https://www.roanokeva.gov/1884/Flood-Preparedness. 2017.
[6] Roanoke Valley Greenways website. http://greenways.org/?page_id=10. 2017.
[7] City of Roanoke. 2017.
[8] USACE.
[9] USACE.
[10] City of Poquoson Preliminary Damage Assessment. 2009.
[11] City of Poquoson Preliminary Damage Assessment. 2011.
[12] VDEM grant records.
[13] Properties 5, 15, 16, 24, 14, 23, and 25 were funded using CDBG rather than HMGP funds, though they were originally included in the HMGP project application.
[14] VDEM grant records.

Appendix M:

Stakeholder Engagement

Hazard Mitigation Assistance Grant Stakeholder Workshop

Workshop Proceedings

August 22, 2017

Submitted to

Virginia Department of Emergency Management

Submitted by

Virginia Modeling, Analysis and Simulation Center

Contents

About the Workshop 4
Participants 5
Agenda 6
VDEM Grant Funding Guidance 6
Ground Rules and Assumptions 7
Grant Allocation Process 7
Stakeholder Collective Planning 8
Commonwealth Priorities 8
Observations/Recommendations: 8
Project Scoring Criteria 8
Criteria Definitions ..... **Error! Bookmark not defined.**
Criteria Weights 9
Criteria Score Values 10
Observations/Recommendations: 10
Next Steps 11

About the Workshop

The Virginia Department of Emergency Management (VDEM) hosted a Hazard Mitigation Assistance Grant Stakeholder Workshop on August 22, 2017. The purpose of the 1/2 day workshop was to promote the improvement of the Hazard Mitigation Assistance (HMA) grant allocation process. The Federal Emergency Management Agency (FEMA) provides grants to states, federally recognized tribes, local communities, and certain private non-profits to assist in pre-and-post disaster natural hazard mitigation activities. Funded projects require FEMA approval and strict adherence to eligibility requirements. VDEM, as the grant administrator for the Commonwealth of Virginia, is tasked with ensuring that projects submitted to FEMA stand the best chance of winning approval, as well as reflecting the values and preferences of the stakeholder community. It was the goal of the workshop to promote transparency and stakeholder involvement in the decision-making process for the allocation of grant funds.

Workshop objectives were to 1) provide stakeholders with grant overview, and future grant scoring process; 2) conduct open discussion of Commonwealth priorities and elicit future recommendations; and 3) refine project scoring criteria, definitions, weights, and value functions. Approximately twenty participants representing multi-disciplinary domains across the Commonwealth's seven regions attended the workshop. The results of the workshop reflect the values, judgment and experience of the stakeholders and would not have been possible without the energetic and engaged input from the participants. The following sections provide an overview of the workshop proceedings including stakeholder inputs, results, and next steps.

Participants

Bruce, Chris	• Virginia Department of Emergency Management (Region III)
Coates, Robert	• Virginia Department of Emergency Management (Disaster Grants)
Daley, Ed	• City of Emporia (Region I)
Dunn, Jenna	• Bland County (Region IV)
Ezell, Barry	• Virginia Modeling, Analysis and Simulation Center
Farole, Allison	• Albemarle County (Region III)
Foresman, Robert	• Henrico County (Region I)
Harrington, Sara	• Virginia Department of Emergency Management (Region IV)
Joyce, Rebecca	• Central Shenandoah Planning District Commission (Region III)
Katchmark, Whitney	• Hampton Roads Planning District Commission (Region V)
Kezele, Jake	• Virginia Department of Emergency Management (Region VII)
Lawsure, Kaleen	• Virginia Modeling, Analysis and Simulation Center
Loftis, Chad	• Halifax County (Region III)
Messmer, Debbie	• Virginia Department of Emergency Management (Disaster Grants)
Mooney, Seamus	• Fairfax County (Region VII)
Owen, Kristen	• Virginia Department of Conservation and Recreation
Pointer, Gwen	• Hampton City (Region V)
Progen, Danielle	• Virginia Department of Emergency Management (Region V)
Roane, Ammoni	• Virginia Department of Emergency Management (Disaster Grants)
Robins, Kathy	• Richmond Regional Commission (Region 1)
Simmons, Jonathan	• Virginia Department of Emergency Management (Region VI)
Stone, Mark	• Virginia Department of Emergency Management (Region II)
Straight, Christy	• New River Valley Regional Commission (Region IV)
Wells, Ed	• Roanoke Valley-Alleghany Regional Commission (Region VI)

Agenda

2017 Hazard Mitigation Assistance Grant

Stakeholder Workshop

Tuesday, August 22, 2017
1:00 p.m. – 4:00 p.m.
Twin Hickory Library
5001 Twin Hickory Road, Glen Allen VA 23059

1:00-1:10	Welcome and Opening Remarks
1:10-1:30	Briefing on previous grant evaluation process and transition to new process
	Robbie Coates, Grants Manager, Disaster Programs, VDEM
1:30-3:30	Facilitated discussion of evaluation criteria language and weights
	Barry Ezell, ODU-VMASC
3:30-4:00	Re-cap of discussion and presentation of final criteria and weights
4:00	Adjourn

VDEM Grant Funding Guidance

Pre-Disaster Mitigation (PDM)

- Annual grant ($90M) for climate resistance, infrastructure, and non-flood related projects
- $575K State set-aside

Flood Mitigation Assistance (FMA)

- Annual grant ($199M) for structure mitigation of insured properties through NFIP
- $160M Competitive
- $70M Community Flood Mitigation
- $90M All other Flood Mitigation Projects
    - Priority to Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties

Hazard Mitigation Grant Program (HMGP)

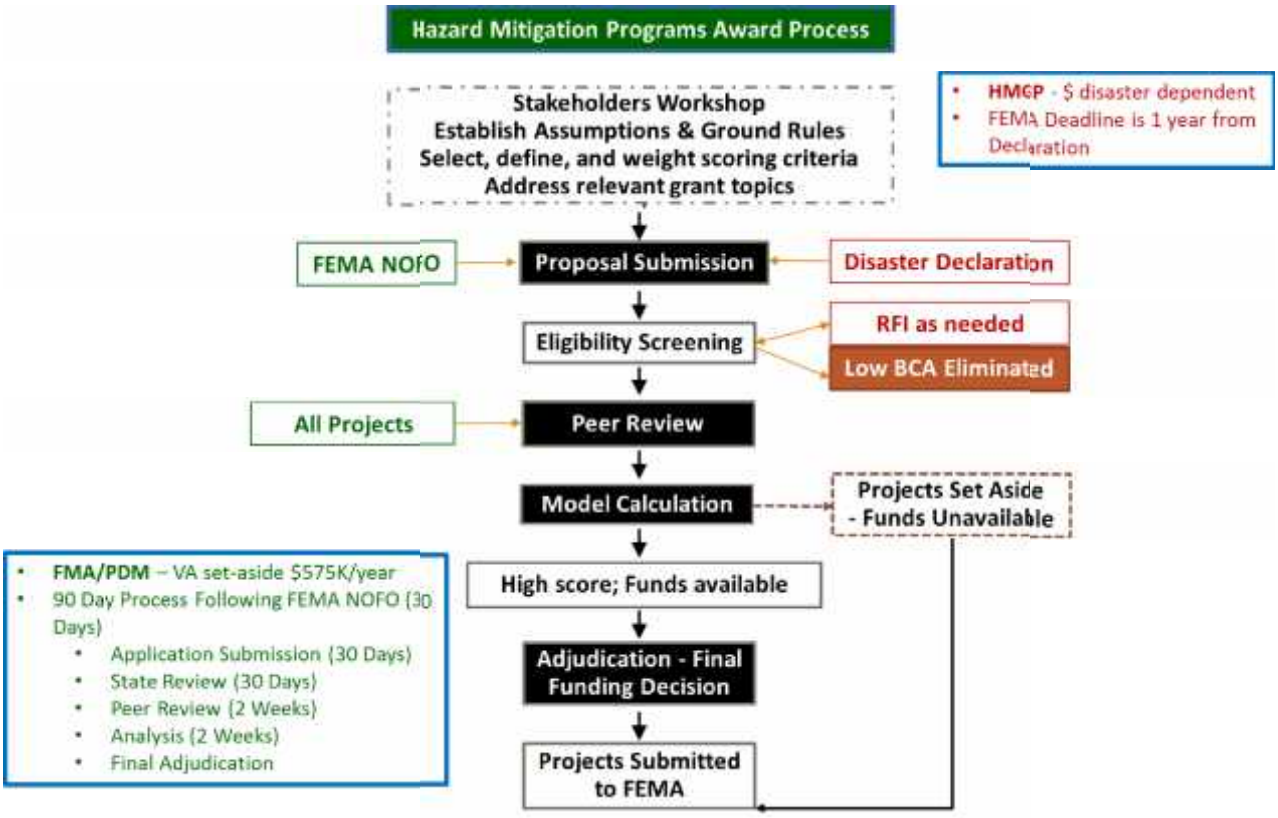
- Post disaster grant to reduce future risk, funding dependent on disaster costs for public /individual assistance programs
- Current amount for Hurricane Mathew - $5,559,397

Ground Rules and Assumptions

- All programs will be peer reviewed by reviewers randomly assigned to projects NOT in their region
- HMGP projects, in addition to peer review, will be prioritized by whether or not the locality was a declared jurisdiction for that event
- HMGP projects are competitive WITHIN Virginia, PDM and FMA are competitive within Virginia and Nationally.
- Priority for HMGP Initiative projects is Alert and Warning
- Priority for HMGP Planning projects is to improve data in mitigation plans
- FMA $90M for RL & SRL will be further prioritized by FEMA for those properties suffering greater than 50% SRL.

Figure 1 is the mitigation grant process flow.

Grant Allocation Process



Stakeholder Collective Planning

After being provided with grant rules and guidance, and the grant process and project proposal scoring methodology, stakeholders were tasked with providing inputs to 1) make recommendations for future Commonwealth priorities; and 2) provide input into scoring criteria, weights and value functions

Commonwealth Priorities

- Climate resilience mitigation activities
- Large scale projects with whole community impacts
- Holistic mitigation measures (protects multiple hazards)
- Infrastructure protection projects
- Alert and warning projects
- State level projects
- Improved data in mitigation plans to drive project development

Observations/Recommendations:

- There is not enough funding available to do large scale projects.
- There is a need for better consideration of projects receiving funding from multiple sources in order to be completed.
- Ranking projects by type was discussed, but rejected by the group.

Project Scoring Criteria

Mitigation Criteria	Definition
Community Impact	The project reduces impact to, and benefits the community through protection of critical infrastructure, facilities and private structures.
Risk Reduction of High Risk Hazard(s)	The project reduces risk from hazard(s) identified in regional all hazards mitigation plan.
Return on Investment	This criterion score will be automatically calculated based on the FEMA Benefit Cost Analysis (BCA) output
Scope of Work and Milestones	The scope of work clearly illustrates the project timeline, including milestones and deliverables as it relates to the performance period.
Project Development Process	The project Application has a clear justification of the objectives, including mitigation alternatives considered and outlines the project development process.

Performance Measurement Plan[1]	The proposal describes the overall results that the project is expected to accomplish in qualitative and/or quantitative terms. Some descriptions could include performance measures, national standards, and core capabilities. The proposal identifies how the project's results will be evaluated and who will evaluate them?
Fiscal Stress Index	Fiscal Stress Score from Virginia Department of Housing and Community Development (DHCD). http://www.dhcd.virginia.gov/index.php/commission-on-local-government/fiscal-stress-in-virginia-local-government.html

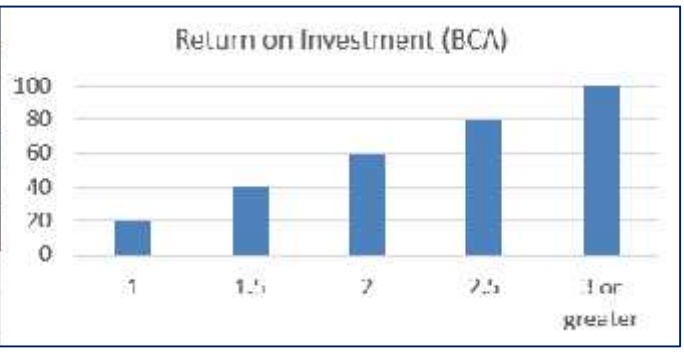
Criteria Weights



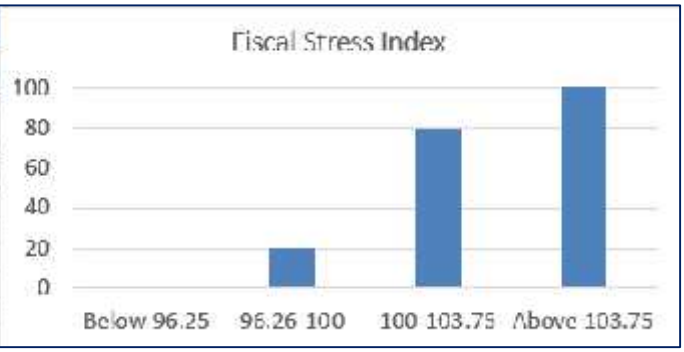
[1] Based on information captured with the current grant application, Performance Measurement Plan will not be used in the current scoring process. Implementation of this criterion will begin in the next cycle.

Criteria Score Values

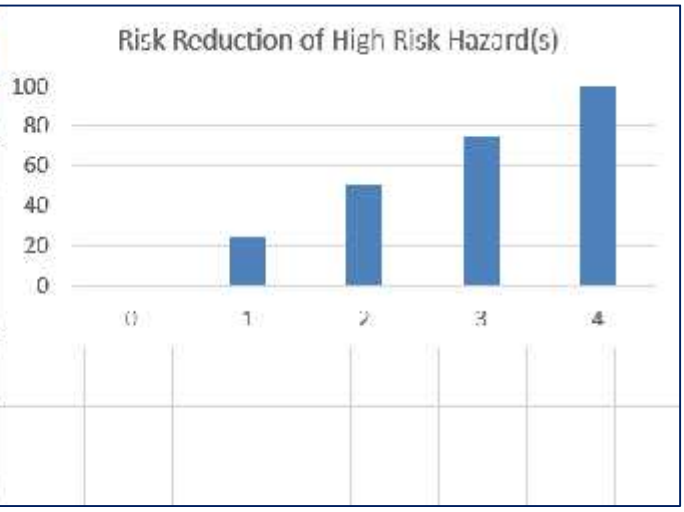
Return on Investment (BCA)	x	v(x)
FEMA BCA Score	1	20
	1.5	40
	2	60
	2.5	80
	3 or greater	100



Fiscal Stress Index	x	v(x)
Low	Below 96.25	0
Below Average	96.26-100	20
Above Average	100-103.75	80
High	Above 103.75	100



Risk Reduction of High Risk Hazard(s)	x	v(x)
The project fails to identify a hazard or reduce risk.	0	0
The project reduces the risk of a low or emerging hazard	1	25
The project reduces the risk of an identified mitigation project from an all hazards mitigation plan.	2	50
The project reduces the risk of one high priority hazard.	3	75
The project reduces the risk of multiple highest priority hazards.	4	100



Observations/Recommendations:

- Future improvements to the grant process could include consideration for projects with multiple funding streams to complete.
- Fiscal stress is important, but future improvements should consider alternatives to using the current DHCD Fiscal Stress Index.
- An effort should be made to reduce/eliminate “Band-Aid” projects.

- Vulnerability, as well as geographic variation in hazard threats and timing of mitigation plan updates should be taken into consideration.
- VDEM could aid reviewers by providing relevant risk information.

Next Steps

- PDM/FMA deadline is September 14, 2017
- VDEM eligibility screening September 14-21
- Peer Review Process – September 22 – October 6 (HMGP and PDM/FMA)
    - Those interested in participating in the peer review can sign-up at **https://odu.co1.qualtrics.com/SE/?SID=SV_cuSpkgX4olFVhWt&Q_JFE=0**
- VMASC Data Analysis/Preliminary Results Presentation – October 6 – 20
- Final Funding Adjudication and Submittal to FEMA – November 3
- FEMA notification of awards – Spring 2018